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ARMY ORDNANCE

VOL. IX NOVEMBER-DECEMBER, 1928 No. 51

16-INCH COAST DEFENSE GUN AT ABERDEEN PROVING GROUND

INDUSTRIAL MOBILIZATION
Charles B. Robbins

MILITARY LESSONS OF THE GREAT WAR
Maj. Gen. Sir Frederick Maurice

POWER IN INDUSTRIAL MOBILIZATION
B. C. Dunn

TRANSPORTATION IN INDUSTRIAL MOBILIZATION
Gilbert Van B. Wilkes

PROCUREMENT OF NONCOMMERCIAL MATERIAL IN TIME OF WAR
R. R. Nix

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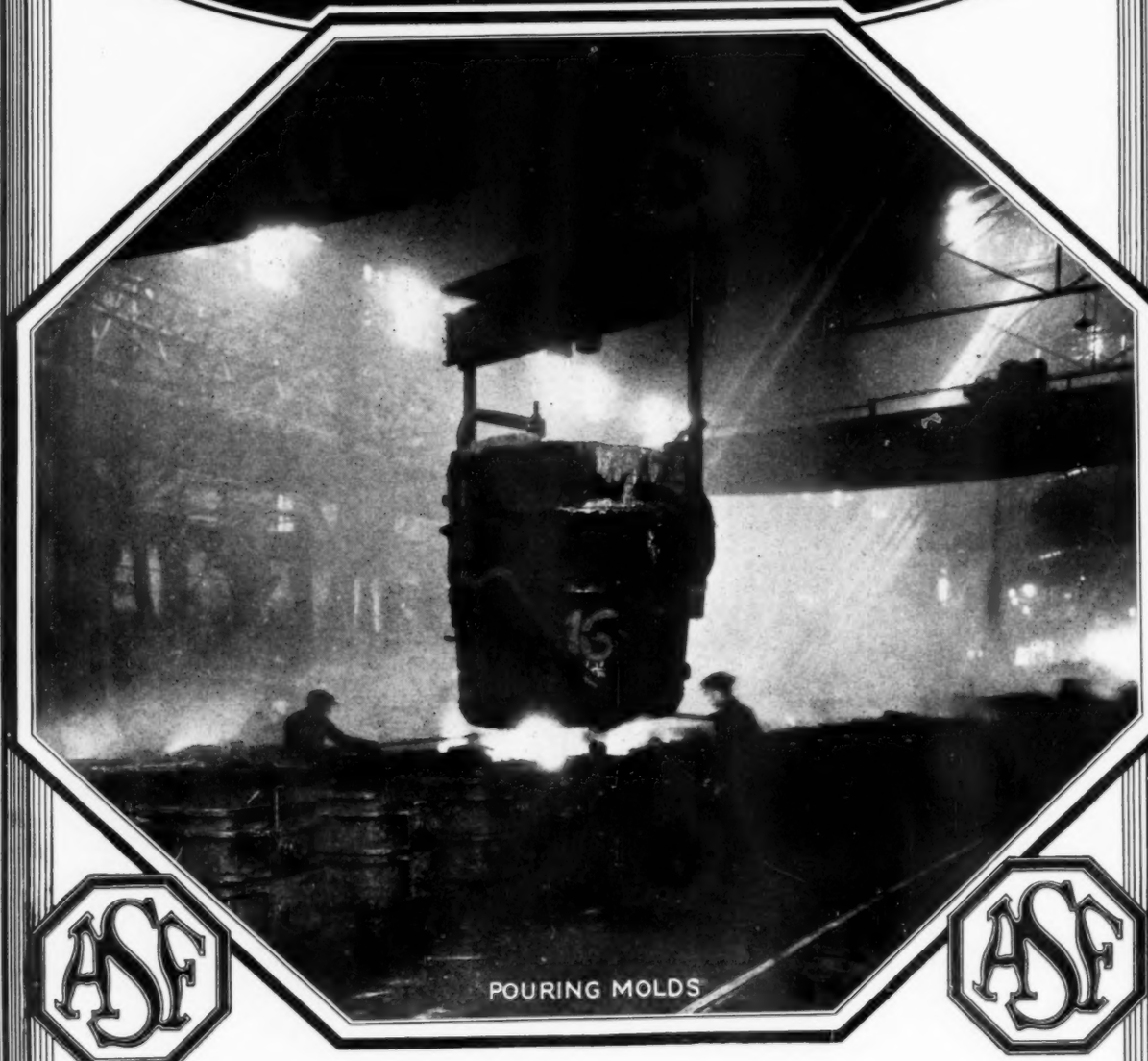
THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

AMERICAN STEEL FOUNDRIES

NEW YORK CHICAGO ST. LOUIS



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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

Published by
THE ARMY ORDNANCE ASSOCIATION
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"No great nation in the world, knowing that America has prepared itself for defense, will ever venture to attack it. It is the best insurance against aggression and it is costing the people of the United States almost nothing in its preparation."
CHARLES B. ROBBINS, *Assistant Secretary of War.*

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THE Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

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To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

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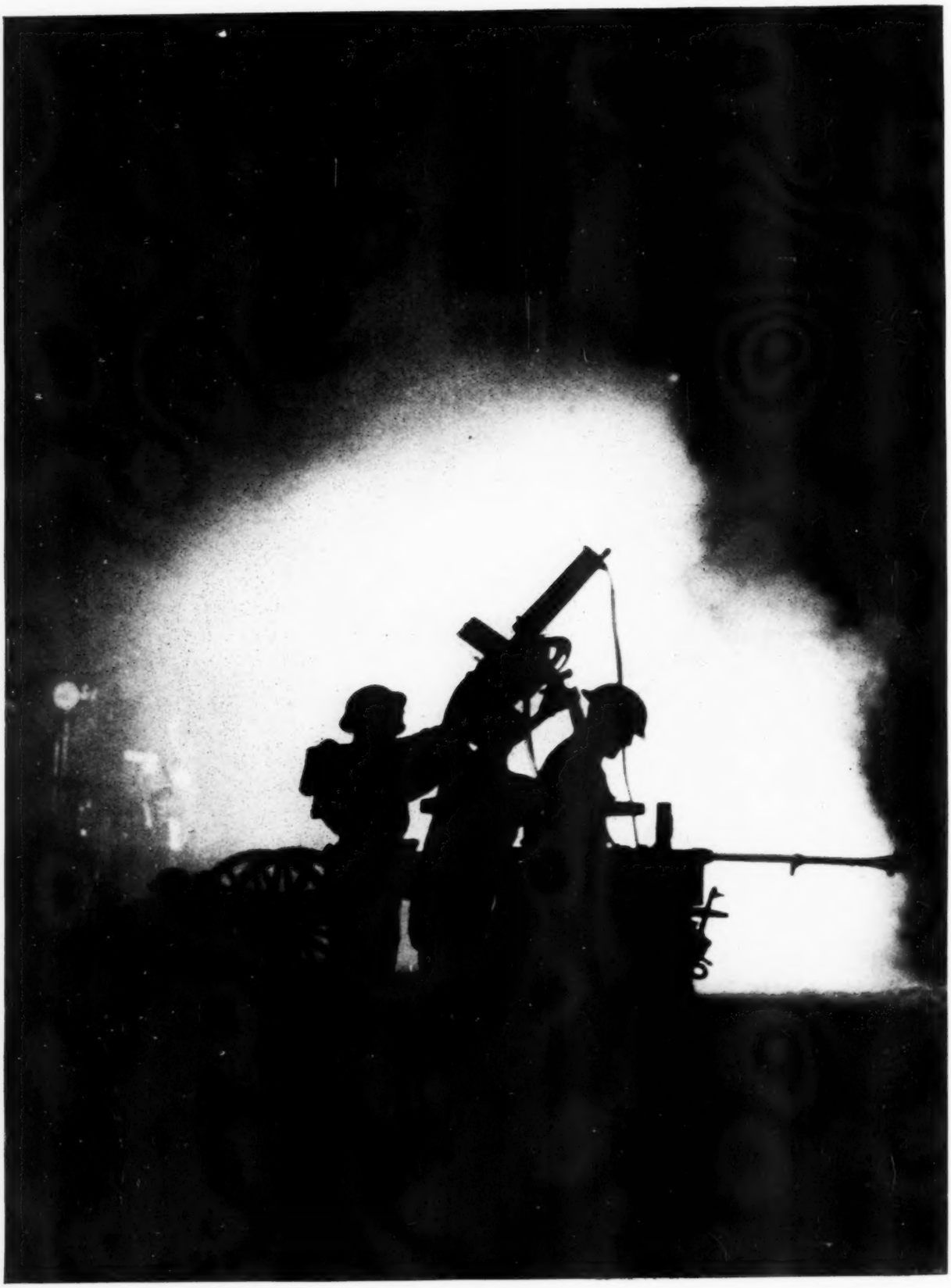


An Antiaircraft Silhouette.

ARMY ORDNANCE

VOL. IX NOVEMBER-DECEMBER, 1928 No. 51

Industrial Mobilization

Its Importance in the National Defense

By Charles B. Robbins

ALL wars have involved the interplay of three great forces—military, political and economic. Up to the time of the World War the military was usually the preponderant force employed to impose the will of a belligerent on an enemy. The late war, however, emphasized the growing importance of the economic or industrial activities due to the vastly increased use of material of all kinds. Since then, all the great nations have realized the necessity of an industrial preparation for war. It is now regarded as of equal importance with the planning for the proper utilization of the man power of the country. Of what avail is a mobilization of man power, one hundred per cent successful, if there is insufficient shelter, if rifles and artillery are lacking, if ammunition fails?

Charles B. Robbins
The Assistant Secretary of War

Reviewing the annals of warfare, there are instances enough of defeat due to industrial failure. Lack of industrial preparedness is no new thing. In the thirteenth chapter of the Book of Samuel we read:

"Now there was no smith found throughout all the land of Israel: for the Philistines said, Lest the Hebrews make them swords or spears * * * *. So it came to pass in the day of battle, that there was neither sword nor spear found in the hand of any of the people that were with Saul and Jonathan."

We are not concerned with the methods adopted by the Philistines to put the munitions industry of the Hebrews out of business. It is clear their policy succeeded and when the Israelites mobilized they took the field without weapons.

Manifestly, the organization of the Office of the Assistant Secretary of War, by the legislation of 1920, corresponded to some essential need developed by the experience of the war. In 1917 and 1918 too many of our men and organizations had found themselves in a situation similar to that described in the foregoing paragraph. They had neither rifles nor artillery and the time was long before our industries furnished the requisite weapons. And this in the face of a situation eminently favorable, due to the development of a tremendous munitions industry as a consequence of the demands of the Allies prior to our entry into the war. Something was decidedly wrong. Was it improper organization or faulty methods of procurement, or both? A brief analysis of the situation as it developed will show the defects.

SUPPLIES needed for the armed forces of the nation are governed by (1) the military program in terms of men, organizations, and time; (2) approved organization and equipment tables; and (3) consumption and replacement factors. Computations, based on these data, determine the quantities of articles of issue to be delivered at various periods of time. But this is not enough. Primary requirements must be translated into secondary requirements, especially raw materials. The report of the Chief of Staff, U. S. Army, 1919, includes the following statement on page 126:

"The Ordnance Department and the Quartermaster Corps alone had developed effective organization for the calculation of requirements for articles of issue. Nowhere in the bureaus had units been established for the conversion of such requirements into terms of their raw material content, yet it was necessary for the War Industries Board to know not only the requirements of finished articles, such as shoes and uniforms, but also the amounts of leather of various kinds, and the amounts of wool, etc., which were involved in making the final products."

Moreover, if the requirements had been known with accuracy there was no central organization where the requirements of each supply branch would be concentrated with a view to the determination of total requirements for the entire Army. It is clear, then, that in this matter of the most fundamental problem in industrial mobilization the condition in 1917 was one of unpreparedness.

The knowledge of requirements is a first essential. The resources of the country, or the facilities by which the required articles are to be manufactured, must be known and listed so as to facilitate purchasing. This was only partially the case in 1917.

Referring once more to the 1919 report of the Chief of Staff, the description on page 111 of the effect of uncoördinated purchasing gives a vivid picture of the conditions that will be quoted verbatim:

"The declaration of war immediately induced the greatest activity in the five supply bureaus and put them under tremendous pressure for the adequate performance of their respective functions on the scale called for by the magnitude of the war. Their personnel was increased with great rapidity. Their structure underwent considerable changes made imperative by the great increase in their tasks. Each bureau felt keenly the duty imposed upon it of obtaining with the greatest speed possible the enormous mass of supplies and material needed for the conduct of military operations. They naturally proceded along established lines, that is to say, as they were independently constituted, each bureau had its own duties to perform and set about those duties in the main without any adequate coördination with the other bureaus or with other Governmental purchasing agencies.

"The war, therefore, began with the supply system of the Army organized on the bureau plan, the bureaus being five separate purchasing agencies with separate systems of finance, storage, and distribution, each feeling itself largely independent within its own sphere of action, and accustomed by long habit and tradition to perform its various functions without reference to the activities of the others or of other departments of the Government. Accordingly, when the Army went into the Nation's markets to buy the vast body of supplies needed for the war, it went not as a single agency, seeing the problem of supply as a whole, but as five separate bureaus competing with each other, as well as with the other great agencies of the Government and of the Allies, for manufactured articles, raw materials, industrial facilities, labor, fuel, power and transportation."

Obviously, there were other defects of procurement, due to the lack of coördination of the supply branches and the methods of purchasing. The major defects of the system have, however, been touched upon. They may be summarized as (1) lack of knowledge of requirements, (2) insufficient knowledge of manufacturing facilities, and (3) uncoördinated and competitive purchasing by the supply branches acting independently of each other. In what way and to what extent does the organization of the Office of the Assistant Secretary of War, as far as its planning activities are concerned, remedy the evils of the old organization?

Nowhere is it assumed that the organization and operations of this office provide a panacea for all our industrial preparedness ills. Experience in the past has necessarily been depended upon to suggest the course of future events. It is realized, however, that new and unexpected developments, impossible of anticipation, will arise to hamper the smooth running of our machine. The machine has been made as flexible as possible, so that its main features can stand the strain, while the strengthening or replacement of certain parts, found wanting, can be carried out without stopping its operation.

GENERALLY speaking, the broad features of the planning work for industrial mobilization involve the following steps, after the General Staff has laid down a military program which must be met:

(1) The first operation is the computation of requirements for articles of issue (primary requirements), and their subsequent analysis into the requirements for raw materials, labor, power, transportation, and funds (secondary requirements), to meet the military program.

(2) The apportionment by the supply branches of the requirements to War Department Procurement Districts, with a view to insuring an equitable distribution of the load throughout the country.

(3) The allocation by the Office of the Assistant Secretary of War of manufacturing plans to the various supply branches, for the manufacture of the articles for which they are responsible.

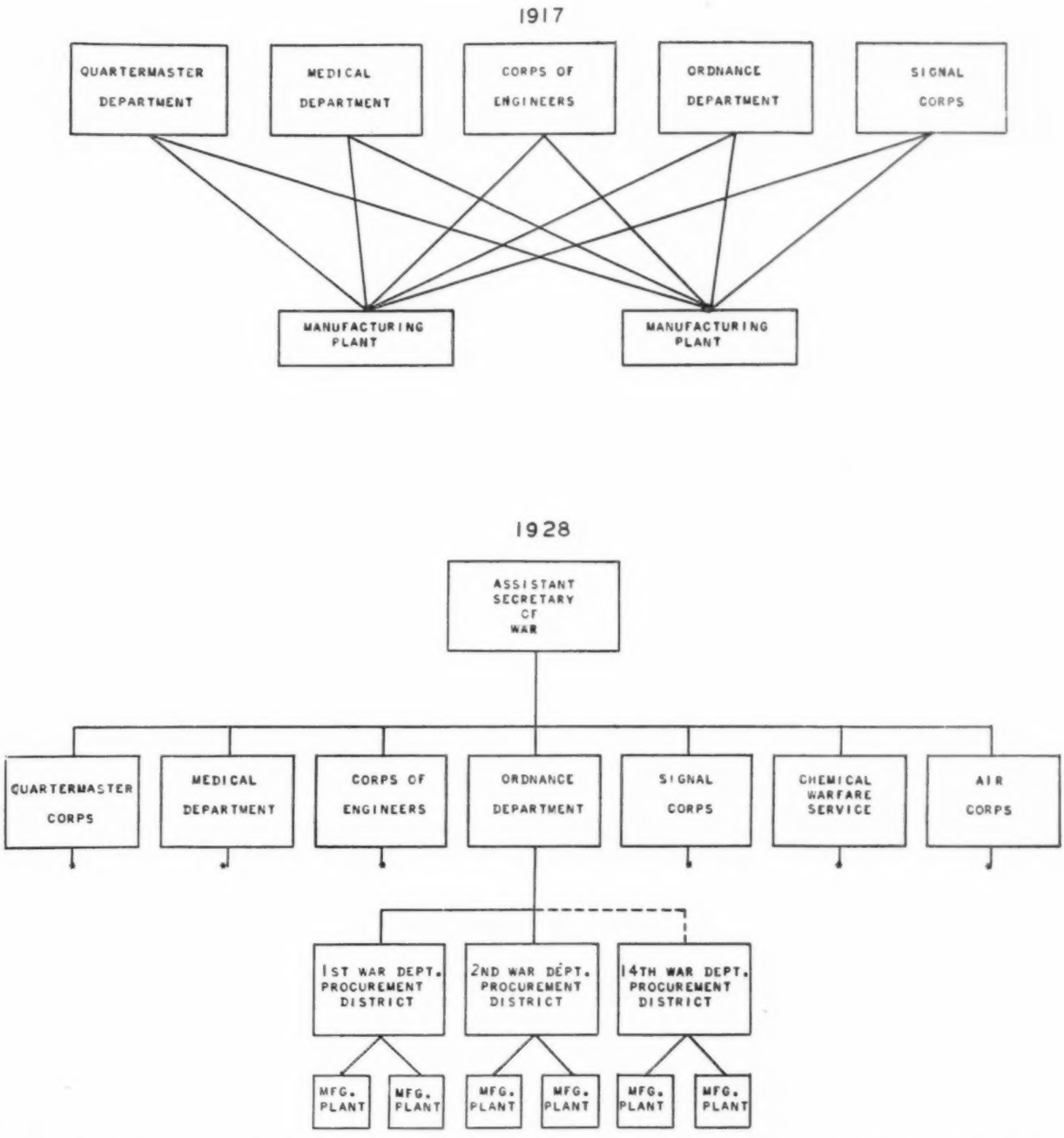
These steps in procurement planning are supervised and controlled by the Office of the Assistant Secretary of War. It is thus seen that there now exists centralized control over the separate supply branches, the absence of which was disastrous in the late war. There is, moreover, not only coördination of one supply branch with another, but the organization of the Army and Navy Munitions Board further insures the coördination of Army and Navy industrial planning. The organization adopted will go far to minimize the shortcomings due to the defective organization of 1917.

In addition to providing a higher echelon in the procurement control operation by organizing the Office of the Assistant Secretary of War, another important step has been taken by organizing an echelon below the supply branches. This is the development of the fourteen War Department Procurement Districts to which procurement will be decentralized in the event of war. The chart, page 145, shows the contrast between the procurement organization in 1917 and that now in force.

As regards methods, the advance that has been made is considerable. Referring to the three principal steps in planning, the present system will be discussed in further detail.

THE War Department now knows the requirements on M Day and for subsequent thirty-day periods after M Day of finished articles that each supply branch must furnish in order to meet the 1924 General Mobilization Plan. This probably represents the maximum industrial effort that the country would be called upon to develop as far as the Army is concerned. The determination of requirements has for its purpose not only the assurance of an adequate quantity of supplies, but it must also be carried out with a view to preventing the equally undesirable feature of an excessive amount of supplies.

There is slight probability that a war will develop exactly as the industrial planning anticipates. In other words,



Contrast in Organization and Control of Supply Branches (From the Standpoint of Procurement only) in 1917 and 1928.
Earlier organization lacks coördination between branches and tends to centralize procurement. Present organization insures centralized control and decentralized and local operations.

*Each supply branch maintains representatives in 14 War Department Procurement Districts as shown on this chart in the case of the Ordnance Department only.

there will be at least one recomputation of requirements after the outbreak of war, and judging from our experience in 1917 and 1918 more than one recomputation would not be surprising. Consequently, this office stands for a simplified practice in this essential step in procurement operation, so that no delay will be caused due to complicated methods of computation. It is considered possible to employ simplified methods that will reduce the time necessary for the computation of requirements to a small fraction of the time now required without reducing the accuracy of the results to an appreciable degree. Regardless of the method, however, it is clear that for the first time in a period of peace the War Department knows what it wants and in what quantity, at various periods after M Day, to meet a major emergency. Moreover, the Requirements and Statistics Section of this office is a coördinating unit which determines total Army requirements, especially in the matter of secondary requirements.

The procurement objective of the supply branches is, in many cases, not the gross figures computed under "require-

ments." From these figures must be subtracted the stocks on hand at any time, including war reserve, which gives the net requirements, or the procurement objective. The question of war reserves is necessarily a vital one to the Assistant Secretary of War. They should be on hand in sufficient quantity in the case of essential items to insure the proper munitioning of troops during the period when the facilities are not able to meet requirements.

The next operation in procurement planning is a purely tentative one, carried out by the supply branches, and involves the apportionment or distribution of net requirements to the fourteen War Department Procurement Districts, or to as many of them as can be called into play, for the production of a particular item. It is then the function of the district chief to submit a requisition for the use of all desired facilities in his district to meet the procurement objective assigned him.

THE third step in procurement planning is without doubt the most powerful weapon in the hands of the Assistant Secretary of War. It is known as "Allocation of Facilities" and means that the right of allocating industries to the supply branches is reserved to his office. Allocation involves a decision to set aside a facility in its entirety, as far as possible, for the exclusive use of a particular supply branch in procurement planning. Parenthetically, it should be noted that the Assistant Secretary of War seeks to carry out his mission with as little disturbance as possible to the economic adjustments in force in time of peace. Among other advantages to be discussed later the allocation of facilities will go far to accomplish this end.

At the present time there are approximately 20,000 allocations, out of which number only 300 represent joint allocations, i. e., one facility assigned to two or more supply branches of the Army or to the Army and Navy. Consequently, the field of conflict between different units in the procurement game is narrowed to those comparatively few facilities which are jointly allocated.

Prior to the allocation of a facility there has been no contact between a representative of the supply branch and the facility in question, but when the requisition from the district chief has been approved this gives him the right to conduct a survey of the particular factory or plant, of course, with the consent of the plant involved. The survey determines the suitability of the facility to meet that portion of the requirements assigned to it, and if satisfactory, accepted schedules of production are placed and factory plans are developed. If, on the other hand, the survey of the facility shows that it is not suited to the projected use, the survey may be submitted to another supply branch within the district, so that it may be allocated to the proper branch.

The industrial load of the Army is thus divided into seven major parts and all facilities of importance to be used in time of war will be familiar with their obligations and responsibilities as a part of a particular supply branch in providing for the common defense.

In connection with the allocation of facilities there is one feature of our industrial planning which deserves more than passing attention. In the last war unexpected demands were made on industry by such new developments as tanks, gas warfare, airplanes, submarine mines. Another war would doubtless bring developments in the use of mechanical equipment unforeseen at present. To meet this we shall maintain a strategic reserve of manufacturing plants in each district, working only on orders involving the use of a very limited proportion of their capacity and capable of undertaking work of a varied nature when the need arises.

Allocation of facilities eliminates the necessity for an elaborate priority system of orders, prevents competition in prices, reduces to a minimum the emergency coördination of procurement in war by the President, and provides an equitable and flexible distribution of war orders, so that production may follow most speedily and reconstruction follow readily without the evils that normally exist in industry subsequent to a major war.

WHEN requirements have been computed and the load apportioned to districts and then allocated to separate facilities, the first steps in carrying out the statutory duties of the Assistant Secretary of War have been performed. His responsibility for supervising the procurement of all military supplies by the War Department and the further responsibility to see that adequate provision is made for the mobilization of matériel and industrial organizations carries with it additional requirements in planning operations. One of these is the supervision of the preparation of specific procurement plans. These are studies prepared by the supply branches for the procurement of each essential item on its supply program. They show on the one hand the requirements for a particular item and on the other the distribution of the load to procurement districts and thence to the various manufacturing plants in the districts. It is written evidence:

(1) That the purchasing officer knows what he wants and is able to tell the manufacturer so that there can be no misunderstanding. (Specifications.)

(2) That the amount required is known. (Requirements computed.)

(3) That the procuring office has decided where it is going to buy what it wants. (Allocation.)

(4) That the manufacturer has accepted the business of supplying the portion of the requirements allotted to him. This is called "Accepted Schedule of Production."

The specific procurement plan involves a study of other elements which is not possible to discuss in the limits of this paper.

In addition to the type of specific procurement plan referred to in the foregoing paragraph, there are special plans for power, labor and transportation, which are prepared directly in the Office of the Assistant Secretary of War. These involve functional studies which are constantly being carried out by the sections devoted to them in this office. Moreover, there are procurement plans for strategic raw materials which are elaborate and detailed studies of requirements and of available resources, together with a study of the best methods to be followed in augmenting resources to meet requirements.

The strategic raw materials studied in these plans are defined as those materials essential to the prosecution of the war, which cannot be procured in sufficient quantities from domestic sources, and for which no satisfactory domestic substitute can be found. The responsibility for the procurement of each of these materials is delegated to the supply branch chief who has paramount interest in

that particular material. Under his direction the procurement plan is prepared in time of peace and revised annually.

In connection with these studies relative to the procurement, conservation and distribution of strategic and critical raw materials for use by the Army, Navy and civilian population, the investigation of possible substitutes is considered of the utmost importance. Each supply branch is pushing this work and has presented a ten-year program with an estimate of the cost involved.

Necessarily the major portion of the studies of industrial mobilization in time of peace can have no test in the proving ground of actual experience. Among possible concrete results are, (1) the search for substitutes mentioned in the preceding paragraph, (2) the adoption of simplified and standardized specifications, and (3) the use of educational orders. This last is an essential step in a properly planned industrial mobilization, designed to keep alive the art of manufacture of non-commercial articles needed to equip an army.

THE foregoing methods of providing for a well ordered industrial mobilization are predicated on certain fundamental principles which can be summarized as follows:

1. Industrial plans are based absolutely and exclusively on military plans and military decisions.

2. In modern armies the volume and variety of military equipment per organization unit tends to increase, so that a million men under arms requires each year a larger quantity of material.

3. The basis for computing requirements should be stabilized in time of peace.

4. Adequate reserves must be maintained to provide essential munitions for the period during which production does not meet requirements.

5. Types of articles should be decided upon in time of peace. In time of war changes of type should be made with the greatest reluctance, and only after carefully considering the disadvantages as well as the advantages accruing from the change.

6. Without adequately trained personnel, the best machinery for industrial mobilization is of slight value.

7. The procurement organization is designed to provide a central administrative direction and control over the supply branches by the Office of the Assistant Secretary of War, while decentralization of operations is secured through the fourteen War Department Procurement Districts.

8. The ultimate purpose of the Office of the Assistant Secretary of War is to insure an adequate supply of material of all kinds to the armed forces in time of war. The supply branch chiefs are charged with responsibilities and vested with authority, but each must realize that his function is tributary to the accomplishment of a balanced supply program. In carrying out his mission, the Assistant Secretary of War will interfere with the supply branch only to the extent that this central purpose shall be clearly recognized and universally adhered to.

If the organization and methods of the Office of the Assistant Secretary of War, designed to insure the orderly mobilization of the industrial resources of the country, prove to be effective, in the event of war there will be a saving of many thousands of lives and millions of dollars of the taxpayers' money; industry will not be disorganized and at the conclusion of hostilities it will be able to resume peace-time operations more expeditiously. Surely, such a desirable achievement justifies the most thorough and painstaking coöperation on the part of all concerned. It is noteworthy that not only within the Army, where these conditions are most clearly recognized, but also in other Government agencies and in industry, the greatest coöperation is being secured to realize the desired end and with the coördination of all these sections of our national life the probability of an effective industrial mobilization is constantly becoming more nearly a certainty.

Planning to meet Army and Navy requirements is of course the most essential and important step in this work of coöperation and coördination. The Assistant Secretary of War is not charged by law with supervision over Naval procurement in any way, but in making provision for industrial mobilization he must know the needs not only of the Army but also of the Navy. We have no knowledge of Naval requirements but in planning for Army procurement, the Assistant Secretary has been cognizant of that fact and has set aside for Naval use all the facilities, which, so far as can be foreseen, will be required for such use. In reserving these facilities for the Navy he has been guided largely by information and counsel obtained rather informally from Naval officers charged with procurement duties. While not an ideal arrangement, it is believed that when Naval procurement plans are made in detail no particular difficulty will be met in harmonizing any differences which may arise by bringing into play the Army and Navy Munitions Board. This board, consisting of the Assistant Secretary of War and the Assistant Secretary of the Navy, is assisted in the execution of its functions by various committees. They operate in much the same manner as the various committees of the War Industries Board and provide a potent agency to secure coördination between the services in matters of supply.

In an article entitled "The Military Lessons of the Great War" in the October, 1928, issue of *Foreign Affairs* (which is republished in this issue of ARMY ORDNANCE), the distinguished British soldier Maj. Gen. Sir Frederick Maurice, Director of Military Operations of the British General Staff, 1915-1918, and author of some of the most brilliant military studies of recent years, such as "Statesmen and Soldiers of the Civil War," and "Lee, The Soldier," sums up his opinion of the importance of industrial preparedness as follows:

"Napoleon gave as his receipt for victory the big battalions; the receipt for future victories is the big factories. If machines of the right kind and in the necessary numbers are to be produced quickly, and if those machines are to be provided with the immense volume of missiles which they are capable of discharging, then enormous demands will be made upon manufacture, demands even greater than those made in the Great War, when the countries of the chief belligerents became arsenals. It follows, then, that in any future war those countries which have a highly developed industrial system and control over the raw materials convertible into military machines and munitions will be at a great advantage; and further, that of those countries the one which has given at least as much thought to the mobilization of its industries as it has to the mobilization of its armies will be at the greatest advantage."

Signal Corps Photo.

French 340-mm. Gun, Manned by American Coast Artillery, Sending its Shells 30 Kilometers. Baleycourt Woods, near Nixeville, Department of Meuse, France, September 26, 1918.

Military Lessons of the Great War

By Maj. Gen. Sir Frederick Maurice*

THE cautious observer who tries to deduce guidance for the future from the experience of the past will do well, when war is his theme of study, to find out what the experts of the past were saying and thinking about war before it came. If he does so he will discover that, within the period in which science has seriously applied itself to the perfection of means of destruction, those experts who have been rash enough to utter prophecies have with very rare exceptions been proved wrong.

The rapid collapse of the regular army of France in 1870 took the military world completely by surprise. Even in Germany at that time the experts were at first unprepared and German General Headquarters, under the leadership of the elder von Moltke, did not at all appreciate the tactical effect of the breech-loading rifle. Knowledge drifted back to them from the front; it was not imposed by them from behind. Military opinion was in general unprepared for either the result or the methods of the Russo-Japanese War; the length of the battles of Liaoyang and Mukden was put down as an exceptional phenomenon, due in part to the methodical caution of the Japanese, in part to the peculiar characteristics of the theater of war. There were few military thinkers in Europe who were not surprised at the ease with which the United States overcame Spain.

Many more examples of the same kind could be taken from the history of the last fifty years. The fact is that as the application of science to industry and manufacture has developed, so has the power to produce new and more perfect weapons increased; but while the effect of scientific improvements upon the former can be and is thoroughly tested, the complete effect of new weapons cannot be tested in time of peace. "In war," said Napoleon, "the moral is to the physical as three to one," and all later experience of war has served to confirm the truth of that saying. It was not merely or even chiefly the effect of the fire of the German heavy howitzers upon the forts of Liege, Namur and Antwerp which brought about the rapid fall of those great fortresses. We know now that lines of trenches held by resolute men could have withstood attack for a long time without the aid of any forts. It was the moral effect on the Belgians of the collapse of the defences upon which they had learned to rely which made it seem useless to them to attempt to oppose to an unexpected form of attack an untried form of defence.

A target has no flesh, no blood, no nerves, and tests on the ranges in time of peace are therefore an unreliable guide as to what will happen in war. Jules Verne and H. G. Wells have shown us that human imagination is capable of forecasting with a reasonable degree of accuracy the future developments of science. But not even these prophets have been able to foretell accurately the effect of the inventions which they foresaw upon the habits and mentality of the men and women who use those inventions.

HOW wrong were the prophets of 1914! With the single known exception of Lord Kitchener, they proclaimed in Great Britain, in France and in Germany that a great European war must of necessity be short. Our socialists

*Director of Military Operations, British General Staff, 1915-1918.

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Signal Corps Photo.

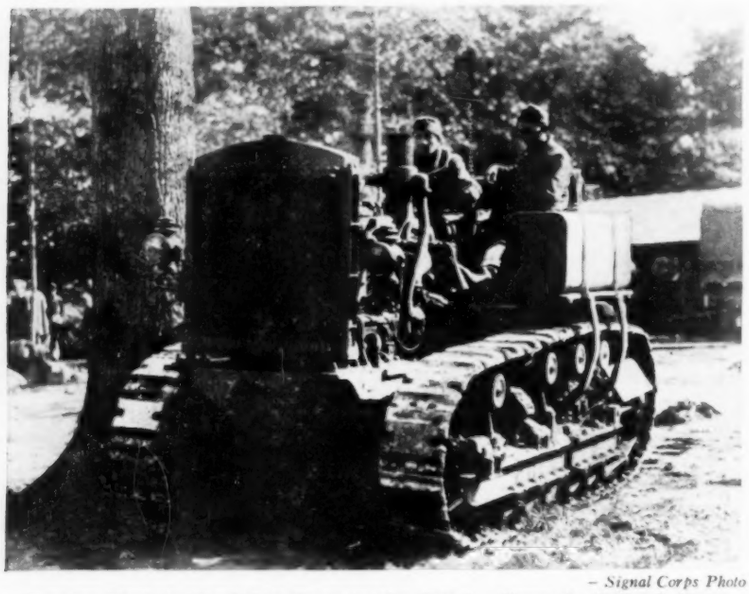
Personnel of Ordnance Department, First Army Corps, Unloading Caissons and Limbers for American 75-mm. Guns, at Artillery Park, Souhesmes le Grande, Department of Meuse, France, September 28, 1918.

are wont to denounce the Great War as the outcome of the machinations of the international financiers, as a capitalist intrigue. In point of fact, if there was one body of men who more than another was reduced to panic, it was the financiers. They could not conceive that society could exist for any length of time without the elaborate and complex machinery which they had created. It was beyond their powers of imagination to conceive of a great modern state deliberately destroying its economic and financial systems and building up another. Therefore with one voice they proclaimed that the Great War would be short. The soldiers followed their lead, and declared that while the financiers, who surely knew best, were certain that the resources of no state were equal to a prolonged struggle between nations in arms, they for their part were equally certain that human endurance could not long stand the strain of subjection to modern means of destruction. One side or the other would collapse before long. The war would be over by Christmas.

Germany, which was militarily the best prepared of the belligerents, had not expected a prolonged war any more than the others. All her plans were based upon a rapid conquest of France, to be followed by a more leisurely progress against Russia. Having full knowledge of the number and nature of the Belgian and French fortresses which she would find barring her way, she had made fuller and more complete preparations for siege warfare than had her enemies. So when trench warfare supervened she was to that extent more ready for it, but in the spring of 1915 she like the others found herself deficient in the artillery, shells and other munitions which the experience of battles in the trench zone proved to be necessary. Nor was it only in the forecasts of the general nature of the war that the military experts of Europe proved to be at fault. The detailed data upon which their plans and preparations were based proved to be defective.

From the signing of the Treaty of Frankfort, which ended the Franco-German war of 1870-71, the probability of the eventual renewal of the struggle had been in the minds of European soldiers. In the two countries chiefly concerned the professional soldiers thought of little else, their whole lives were devoted to the study of the probable nature of the prospective war and the best methods of conducting it. Elaborate and costly systems of espionage were built up in order to obtain information. Germany in particular was credited with knowing everything of military importance which took place in the countries of possible enemies. France, whose very existence was at stake, was believed to be well-informed as to the military preparations of her chief enemy. Then not long before the outbreak of war came the development of the aeroplane; while rudimentary compared with its present powers, it appeared to be at least sufficiently effective to ensure timely knowledge of the movements of large bodies of troops. It seemed in the summer of 1914 to be altogether incredible that whole armies would be maneuvered in secret.

YET what happened in August, 1914? The French plan of campaign, the famous Plan 17, had been gradually and slowly evolved by the best available military brains of France. It was based upon information painfully collected during a long term of years. The probability of invasion of Belgium by Germany had for years been a military commonplace. Despite all this, when the invasion actually took place and the two armies were locked in conflict, the French calculations were suddenly discovered to be erroneous. The whole basis of their plan of campaign was defective because they had grossly underestimated the strength of the forces which Germany could put into the field. The French plan was based on information to the effect that the main German attack would be made from the direction of Metz, and that the Germans had not suf-



– Signal Corps Photo

Tractor Used to Haul Big Guns to the Front. Camp de Galbert, Near Amphersback, Alsace, Germany, August 21, 1918.

ficient troops to extend their front to the west of the Meuse. The error was not discovered until more than 400,000 Germans had crossed the Meuse and the capital of Belgium had been occupied. The first news that Germans were marching through western Belgium was indeed received with complacency at French Headquarters, because it was calculated that if the Germans had extended their left so far they must have weakened their center, which would be broken by the French attack. Not until August 23, ten days after the whole of the German armies in the west, some 1,500,000 strong, had been drawn up on the frontier, was it discovered that the Germans were powerful enough both to repulse the French attacks upon their left and center and to overlap and envelope the Allied left in great strength. Then the elaborately prepared French plan of campaign came tumbling down like a house of cards.

Even more surprising in view of the military omniscience with which the Germans were credited, was their complete ignorance of the movements of the British Army. The British Army was very small in comparison with the conscript hosts of the Continent, and German soldiers were not disposed to rate its military qualifications highly. It therefore is perhaps not astonishing that the German General Staff informed the German Navy that it attached no particular importance to attempts to interfere with the passage of British troops across the Channel. German Headquarters, in fact, regarded the landing of British troops in Belgium as a positive advantage and hoped to take them and the Belgian Army in their stride towards France. Of that state of mind there is definite evidence, but I may mention incidentally that there is no foundation in fact for the story that the Kaiser described the British Army as "contemptible" and instructed his generals to devote all their energies to its destruction. This is one of those war fictions which has become so firmly established, in England at least, that its demise cannot be foreseen.

If the Germans in August, 1914, had no fears of the effect upon their plans of British military intervention on the side of France, every one with knowledge of the thoroughness and care with which their military preparations were made anticipated that they would have had more than an inkling of the form that intervention would take and would have arranged to get early information of the British landing. Now the advanced parties of the British Expeditionary Force landed at Havre on August 9, 1914. By August 17 the whole had disembarked. From August 14 onward they began to move forward by rail to their place of concentration behind the French fortress of Maubeuge, and 100,000 combatant troops were there assembled by August 20. For six days hundreds of trains had been convoying them across the north of France. On August 21 the British Army began to march forward to Mons, which it reached the next afternoon. Yet on August 20 German General Headquarters telegraphed to von Kluck, who was then about to occupy Brussels: "Disembarkation of the English at Boulogne and their employment from the direction of Lille must be reckoned with. The opinion here however is that large disembarkations have not yet taken place." So on August 23 von Kluck advanced on Mons in ignorance that he had in front of him the whole British Expeditionary Force.

THESE things being so, one cannot but be mildly surprised at the courage and confidence of those who write of the nature of the next war. Surely if experience is any guide the one thing that is reasonably certain is that if another great struggle between great powers takes place it will produce as many surprises as did the last.

Yet we are not without some guidance as to the general nature of the developments which we may expect. There have been in the past many wars which were longer than the Great War. There have been none in which the opposing armies were permanently in contact, in which men were being killed and wounded every day. There have been none in which the numbers engaged have been so huge. These, rather than shells of great size, thrown great distances, poison gas, tanks and aircraft, were the outstanding characteristics of the Great War. In that war, as in former wars, battles were incidents in campaigns, though they were of far longer duration. The feature that was without precedent was that from the first day to the last the guns never ceased firing. This was the consequence of the establishment of a continuous barrier of trenches, which limited maneuver and kept the opposing armies permanently in contact.

To what was the continuous trench barrier due? Obviously to the vast numbers engaged on either side. For the first time in history entire nations were in arms. But the appearance of that phenomenon in the years between 1914 and 1918 was not caused by any drastic change in the machinery for making armies. Conscription, the establishment by law of the right of the state to call every able-bodied man to arms, may be dated from 1792, the year of Valmy. In 1870 that method of raising armies was well established and almost universal on the Continent of Europe. Yet at the outbreak of the Franco-Prussian War of that year we find that the German states placed in the field

on the frontiers of Alsace-Lorraine armies numbering 380,000 men, and that France opposed them with armies of 275,000 men. Each power made the greatest initial effort of which it considered itself to be capable. Forty-four years later, in August, 1914, Germany drew up along the frontiers of France and Belgium 1,500,000 men, and France opposed them with armies numbering 1,000,000. The initial military effort of the two countries had increased fourfold, and it was rapidly developed until armies came to be numbered by millions, not by hundreds of thousands. There had been no corresponding increase in the man power of the two countries. This remarkable change which, as I have endeavored to show, altered the form and nature of war far more drastically than did any development of weapons or of military methods, was the consequence of other changes that had no direct connection with war.

Signal Corps Photo.

Tank on its Way Through to Assist American Soldiers. Varennes, d'Argonne-Meuse, France, August 26, 1918.

THE prime cause of the expansion in the size of armies, which took place at the beginning of the twentieth century, was the expansion which took place in the means of transportation. Napoleon said truly that his armies moved on their bellies, and, given an adequate supply of men, the size of armies which can be maintained in the field depends first and foremost on the means available for keeping the bellies filled. From the days of Alexander and of Hannibal to those of Napoleon there had been no material changes in the means of transportation; roads had improved in numbers and in quality, but the animal-drawn vehicle remained the chief reliance of the commissariat. The development of railways in the first half of the nineteenth century brought about important but not drastic changes. They enabled the rate at which armies could be set in the field to be greatly speeded up, and in 1870 the process of mobilization both in France and Germany was much shorter than it had been at the outset of any previous war. But troops cooped up in trains are without any means of defence, they cannot be brought to a battlefield by train, nor could trainloads of supplies be carried safely by rail into the immediate zone of military operations. They had to be unloaded at depots at a safe distance behind the front. There remained, then, a considerable zone within which men had to march, and their supplies had to be carried as before in animal-drawn vehicles. With the invention of quick-firing rifles and guns the amount of ammunition required had increased greatly, so that at first railways made little difference to the amount of animal transport which armies required, and this requirement still placed a strict limit on the number of men who could be put in the field. The columns of animal-drawn transport could not be allowed to expand indefinitely, since that would cause such congestion as would make the regular delivery of supplies impossible, while if the roads in the rear were blocked with slow-moving transport the possibility of maneuver would be confined to a straight forward advance. Until the beginning of the twentieth century transportation still imposed a definite limit on the size of armies.

Then came the application of the internal combustion engine to road transport, and with it a further improvement in the number and quality of roads. By the time the motor vehicle was perfected the number of railways had greatly increased, until the chief European countries had a complete network of rails. The motor lorry could carry from three to four times as much as the horse-drawn vehicle occupying a similar space on the road, and could travel six times as fast. It could bring up supplies from convenient depots on the railways situated at a safe distance from the front, deliver them to the troops, and return rapidly, leaving the roads behind the armies clear. Transportation had ceased to be a limiting factor in the size of armies.

THERE remained one difficulty to overcome before vast armies could be maintained for any length of time in the field. In all wars before the Great War disease had proved to be at least as great a cause of loss as the enemy's bullets and shells, in most of them a greater one. Large bodies of men could not be kept together for any length of time without suffering from some form of epidemic disease. In the South African War, Great Britain lost far more men from enteric fever than she did from the bullets of the Boers. But while scientists of one kind were giving their minds to the solution of the problems of transportation, those of another kind were solving the problem of sanitation, with the result that in the Great War armies of unprecedented size were kept healthy, though the men in the ranks were living under conditions such as human beings had never been called upon to endure for a like period.

Now the development of railways, motor transport, and roads, and the progress of medical science, had not been brought about with a view to war. A few so-called strategic railways had been built primarily for military purposes in France and Germany, and in those countries especially consideration had been given to military needs in designing railway stations and in placing sidings. But the great increase in railways in the latter half of the nineteenth century had taken place to meet the industrial and social needs of the people. Motor transport was adopted by armies after its utility for industrial purposes had been proved. I doubt whether a single scientist or medical man

had thought of the application of his discoveries to war while he was working in his laboratory to discover means of lessening the incidence of disease. We thus come to the conclusion that these changes in the nature of war, which made the Great War so different to any wars which had preceded it, were not due to any purely military inventions or methods, but to changes which had taken place in the ordinary life and methods of peoples, changes and developments designed for the purposes of peace. This, then, I regard as the most important military lesson of the Great War, and as the best guide to speculation on the nature of future wars.

IT is the usual experience that after any important war public opinion should be impressed by the effect of such new weapons as have been used, and that speculation should be rife as to what new terrors those weapons may have in store for us. This has been more than ever the case in the years that have followed the Great War, for the average man and woman has become acutely conscious of the fact that aircraft promise to extend almost indefinitely the danger zone in war. A far more general interest is therefore now taken in speculation as to the nature of future war, and there is also a far more general and sincere desire to do everything that is possible to avoid war. But as I have pointed out, attempts to forecast the nature and effect of weapons to be used in future wars have been very rarely successful. In these days the life of any particular weapon is comparatively short. The limits of the application of science to the means of destruction has not yet been reached. For every existing weapon some antidote is usually found sooner or later, and the discovery of the antidote tends in time to the discovery of some fresh weapon to which the antidote is not an effective reply. For these reasons I do not attach more than a secondary importance to speculations as to the effect of tanks, poison gas, aeroplanes, or other instruments of war which first made their appearance in the years 1914-1918. It is of greater importance to consider what developments are in progress in the lives of peoples which are likely to effect the nature of war.

NOW the outstanding feature of our age is that every day all of us are coming to rely more and more upon machinery. Our industries and indeed our personal comfort are more and more dependent upon the factory and less and less upon the output of human labor unaided by the machine. In the military world a like process is at work. It has for a long time been applied to navies, and the modern battleship is now a mass of intricate machinery enclosed in steel cases. As a result of the experiences of the Great War armies are following the examples of fleets. In that war the supply of munitions, and therefore the importance of the manufacture and the supply of material convertible into munitions, attained an importance beyond comparison greater than in any former wars. Plans for battle were dependent to a predominant degree upon the number of guns and shells available. This was of course largely due to the fact that the existence of the trench barrier allowed ample time for preparation. But one result of the experience gained is that military thought everywhere has been impressed by the fact that the unprotected rifleman, however numerous he may be, cannot produce a volume of fire at all comparable with that produced by the right type of military machine. Armies therefore are going through a process of mechanization; and whether the particular weapons with which they are now armed survive the test of war or not, it seems certain that changes will take the form of reliance upon other and better machines rather than upon the development of man power. Man power will be wanted elsewhere as well as at the front.

Napoleon gave as his receipt for victory the big battalions; the receipt for future victories is the big factories. If machines of the right kind and in the necessary numbers are to be produced quickly, and if those machines are to be provided with the immense volume of missiles which they are capable of discharging, then enormous demands will be made upon manufacture, demands even greater than those made in the Great War, when the countries of the chief belligerents became arsenals. It follows, then, that in any future war those countries which have a highly developed industrial system and control over the raw materials convertible into military machines and munitions will be at a great advantage; and further, that of those countries the one which has given at least as much thought to the mobilization of its industries as it has to the mobilization of its armies will be at the greatest advantage.

It follows, moreover, that the importance of effective organization for the higher direction of war is greatly increased. The difficulty of insuring coöperation between the political and the military direction of war became very apparent in the Great War. In most of the European countries the soldiers and the statesmen were at one time or another at loggerheads. It is the business of professional soldiers, sailors and airmen, to think about war, but with rare exceptions they are ignorant of statecraft. Those whose business it is to think of statecraft, particularly in countries with a democratic system of government, are usually far too occupied with the daily demands of the political situation to give regular and consistent thought in time of peace to an eventuality which may never arise. The causes of friction in time of war, necessarily a time of stress, exist in most countries, and in most countries the trend of political development tends to increase them. But unless and until war as a means of settling international disputes is abolished, the causes of friction must be removed if war is to be conducted successfully and with the minimum of loss.

The developments which I have indicated as probable make the role of statecraft in war of greater importance than ever. Organization for war now means not only the organization of armies and navies, but the organization of the whole of the resources of the state. When war comes, the correct allocation of those resources is a matter of supreme importance. The proper direction of industry will be as vital as good generalship; the correct distribution of man power between the demands of armies and navies and the demands of industry will call for the nicest consideration. The Great War showed us over and over again how supremely difficult it was for the statesman to guide wisely, without ill-considered interference in the technical spheres of the soldier and sailor. So long as the possibility of war remains, statesmen must learn that their part in its conduct will in future be even more difficult and of far greater importance than it has been in the past. The correct coördination of statecraft and strategy is more than ever the key to the successful conduct of war. These are the main military lessons of the Great War.

Congested Conditions at Weehawken Terminal, New Jersey, 1917.

Transportation in Industrial Mobilization

By Gilbert Van B. Wilkes*

THERE is no need to dwell on the importance of transportation in the scheme of war-time procurement. It is involved in every stage of the process from the collection and concentration of material and parts, to the movement of the finished article from the factory to the depot, or to the theatre of operations. The load which is thrown on transportation as an incident of a major war is not only great in absolute magnitude but is especially difficult to handle on account of the unusual routings and of the urgent and imperious nature of military requirements.

The term "common carrier" is defined to include railroads, shipping, pipe lines, sleeping-car companies, express companies, truck and bus lines, special car lines, etc. The Transportation Act of 1920 classifies even telegraph, telephone and radio companies under this heading. I intend to confine my remarks in this paper to the discussion of a few points connected with the transportation of freight by rail in the zone of the interior.

There are between 1,400 and 1,500 railways in the United States, about 175 of these are listed as Class I roads. Owing to the high fixed charges under which railroads must operate, there is and always has been the most intense competition for ton mileage. This forces the carriers to become involved in all the active competitive conditions existing between sections, cities, ports, industries, and markets. Their insatiable quest for tonnage and the loyalty which they owe to their customers and stockholders are characteristic of railroads and must be given full consideration in the study of war-time control of transportation.

Each independent railroad owns a number of locomotives and cars of different sizes and kinds. Theoretically, it is supposed to have enough of each of these to provide for all the transportation needs of the territory which it serves. Few, if any, railroads have sufficient equipment to handle their maximum peak load and it is a normal practice for them to hire equipment from other roads to meet unusually heavy temporary demands. In time of peace, peak loads do not occur on all railroads of the country simultaneously.

Railroads now permit loaded cars to pass freely out of their control onto connecting lines, and do not unload and reload freight at junction points. To insure the prompt return of the cars to the home railroad and their maintenance while away from home, codes of car service rules and master car builders and national car demurrage rules have been adopted generally. Regular per diem rentals and demurrage charges are assessed and collected as penalties for unnecessary delays to cars at loading or unloading points or for their use on "foreign" lines. The procedure now in force represents the survival of the fittest. The railroads have tried out in the past several methods of pooling their equipment and controlling the return of empties. They are constantly striving to improve the general efficiency and to lower the cost of their service, as is shown by the fact that the annual amount of freight transported per $100.00 invested capital has changed from 983 ton miles in 1890 to 2,063 ton miles in 1920. The great efficiency that has been attained in the distribution and movement of cars under the present system has been demonstrated in the movement of the large grain crops of recent years under the emergency conditions created by the general adoption of "combines" and by the shortage in farm and local storage facilities.

In spite of the competitive nature of the business of transportation, or rather on account of it, the railroads have developed a number of well recognized associations, bureaus, and committees to adjust their conflicting interests and to coördinate their operations where necessary. At the head of these organizations is the Association of Railway Executives, which has as its members practically all the Class I roads, each represented by its president. This association has assumed executive control over all railway or railroad associations.

The most important of these associations is the American Railway Association, which has become since the war the

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general trade association of the transportation industry. All steam railroads in the United States operating 100 miles of railroad or more are eligible for membership. The members have votes at the rate of one vote for every 1,000 miles of line operated, or fraction thereof. Membership in the association is entirely voluntary. A member can withdraw by formal announcement at any time upon payment of all dues that have accrued to date. The object of the Association as stated in its articles of organization is, *by recommendation*, to harmonize and coördinate the principles and practices of American railroads with respect to their construction, maintenance, and operation.

IT will be recalled, that upon outbreak of the World War in 1917, the conference of railway executives combined the Car Service Commission, a railroad organization for supervising the enforcement of the car service rules, with several committees on military transportation and with the special committee of the American Railway Association on national defense into a committee of 25 for coördinating the activities of the railroads during the war. From this committee was elected the executive committee of five, generally known as the Railroads' War Board, which was in general control until the railroads were taken over by the President.

Since the war, the car service rules have been enforced under the supervision of the Car Service Division of the American Railway Association. The division draws its powers and authority from the Association as they are laid down in Rule 19 of the Code of Car Service rules. The Car Service Division is invested with plenary powers: to supervise the application of car service and per diem rules, suspend or permit exceptions to the rules, exempt cars of a stated type from operation of the rules, transfer cars from one railroad or territory to another when necessary to meet traffic conditions, with *due regard to car ownership and requirements.*

The Car Service Division is organized along territorial lines, for which purpose the country has been divided into 14 districts, each under a manager.

The shippers in each district have been induced to form a shippers regional advisory board. These boards meet periodically to discuss local car service and prepare and submit estimates of the requirements of the district in freight cars for the next succeeding period. They furnish a forum to which complaints and suggestions from the public can be brought for discussion with the railroad representatives.

The powers of the Car Service Division are only those that are voluntarily conferred on it by the subscribing railroads and as any railroad is free to withdraw from the association at any time, it would appear that these powers are hardly adequate to handle conditions of a widespread emergency. Generally, each railroad estimates in advance its needs for cars and provides for these needs by impounding and distributing its own cars and if necessary by renting cars from connecting lines. Railroads having surplus idle cars are willing to rent them to other carriers having need for them. The Car Service Division gives assistance in meeting local emergencies by suspending car service rules when necessary and by issuing orders and instructions to expedite the return of the cars belonging to the railroads on which the emergency falls. By its nature it cannot assume the role of dictator and disregard the rights of the railroads owning the equipment, no matter what the emergency.

Each member of the American Railway Association has subscribed to the car service rules and has especially agreed to respect the authority conferred on the Car Service Division by Rule 19. In addition they have each named the Car Service Division as the agent upon which "Service of all orders and directions with respect to car service of the Act to regulate commerce in force at the time, may be made by the Interstate Commerce Commission for and in the subscribers behalf." This agreement continues in force until withdrawn by three months' previous notice in writing. The Interstate Commerce Division, since the passage of the Transportation Act of 1920, is vested with dictatorial authority in time of emergency. The following are some of the powers specifically given it:

a. It may establish *reasonable* rules, regulations, and practices with respect to car service including rentals, penalties, etc.

b. Whenever the Commission is of opinion that shortage of equipment, congestion of traffic or other emergency requiring immediate action exists it can (1) suspend car service rules; (2) issue just and reasonable orders with respect to car service *without regard* to ownership of equipment and determine just compensation to the individual carriers; (3) require joint use of terminals and main tracks; (4) give priority or preference in transportation, declare embargoes or movement of traffic under permit. "In time of war the President may certify to the commission that it is essential to the national defense and security that certain traffic shall have preference or priority in transportation and the Commission shall have the power to direct such priority or preference to be afforded."

THE system of coördination of the railroad car service now in force seems almost ideal. It has made it possible for the railroads to handle an increasing tonnage with an almost constant supply of cars and with scarcely any car shortages. The powers of the Interstate Commerce Commission seem sufficient for railroad control in war. Such a system of control seems immensely superior to the establishment of an emergency railroad administration, with the accompanying assumption of unknown financial and operating responsibilities by the United States. Under the existing organization, the railroads would probably weather a very serious military emergency if the problems of procurement and mobilization were met in a reasonable and systematic manner by the responsible Government agencies.

Failures in the railroad service are caused most often by the shortage of rolling stock or by the overloading and blocking of terminals.

Those who are charged with procurement in war have a great responsibility in this matter and should do everything possible to prevent the breakdown of transportation. Military necessity is of course paramount, but, in the zone of the interior, it is not frequently so compelling that other considerations should be entirely ignored. The following are some of the ways in which the burden on the railroads may be minimized:

(1) Priority should apply to dates of shipment but not to transportation. After freight is loaded it should go through to destination without interference. The number

of classifications that can be made in any railway yard are limited. Sticking up the cars with red, blue and white priority signs either will have no effect or will tend to block and congest terminals.

(2) Do not permit freight to be loaded for shipment until there is a place for its receipt at destination.

The several branches of the Army should provide themselves with sufficient branch storage to insure that freight will not pile up at factories or at terminals in case of a change in the military situation.

(3) Comply with current car service rules. Avoid demurrage. Leave routing to railroads and control agencies, unless there is a real advantage in specifying it. The advantages of direct routing over the circuitous routing sometimes selected by rail officials is often exaggerated. The use of all possible routes between terminals prevents congestion, expedites delivery and avoids transportation claims from railroads injured by arbitrary diversion of traffic.

(4) It may become desirable to require the general use of Government bills of lading in the shipment of all war supplies. In this way absolute control can be gained over the routing and cost of transportation. The bill of lading could be withheld for a time in accordance with priority decisions, or on account of terminal conditions at destination.

(5) Less than carload shipments should be avoided wherever possible. Less than carload freight may be collected in each War Department procurement district by truck and delivered to designated shipping centers for loading into full carload lots. Motor trucks can often be used to great advantage in coördination with rail transportation. The transportation corps will be primarily responsible for working out such uses but branch district procurement chiefs should be on the alert to recommend improvements in the service.

(6) Shippers regional advisory boards furnish a ready means to coördinate war necessities in car service with those of the civilian population. It may be possible materially to control nonessential uses of railroad equipment by voluntary action of the shippers themselves.

UPON the outbreak of a major war, the railroad executives will find it incumbent upon them to remove certain restrictions upon the joint use of terminals and other facilities which have existed under conditions of free competition and take such other action as will expedite and simplify the movement of freight. The manufacturers of military supplies will ship their products to the prescribed points of delivery in the usual manner and will individually make arrangements with the railroad that serves them for car service, etc. Procurement officers will insist that all shipments are made as simply as possible. Routings will be left to the railroad, unless there is a positive reason for prescribing a definite routing. An agent of the American Railway Association will be located in each War Department procurement district to advise as to routings and other transportation matters. The transportation officer in each district will give assistance where possible. He may organize trucking lines to handle less than carload and local shipments and will prepare and issue all Government bills of lading that may be required.

Simplicity and uniformity are the governing principles in handling the mass transportation requirements of war. Arousing competition between the carriers should be avoided. The Interstate Commerce Commission has sufficient powers to remedy conditions that cannot be satisfactorily dealt with by the individual roads or by the American Railway Association. District chiefs should see that freight is not delivered to the roads until the receiver at destination is ready to receive it. Expedited or priority shipments should not be permitted except in most unusual circumstances.

Milwaukee Post, Army Ordnance Association, Organized

THE formal organization of a Milwaukee Post of the Army Ordnance Association took place September 26, 1928, in Milwaukee.

Wm. W. Coleman, as chairman of the organization committee elected at the last informal meeting, called the meeting to order. This committee consisted of Colonel Coleman, Harry G. Martin and George H. Boyer. Roger Sherman Hoar was elected temporary chairman and Captain Boyer was elected temporary secretary.

Major Hoar, on taking the chair, read the sections of the By-Laws of the national Association relative to local posts. Colonel Coleman was then called upon to read wires, letters and telephone messages from absent members and a telegram of congratulations from the Secretary of the Association.

The temporary chairman was then authorized by vote to appoint a committee on constitution and a nominating committee. On the constitution committee he appointed Colonel Coleman, Captain Boyer and Mr. Ernst Beste. On the nominating committee he appointed Colonel Martin, Maj. Robert E. Friend and Lieut. N. R. Knox.

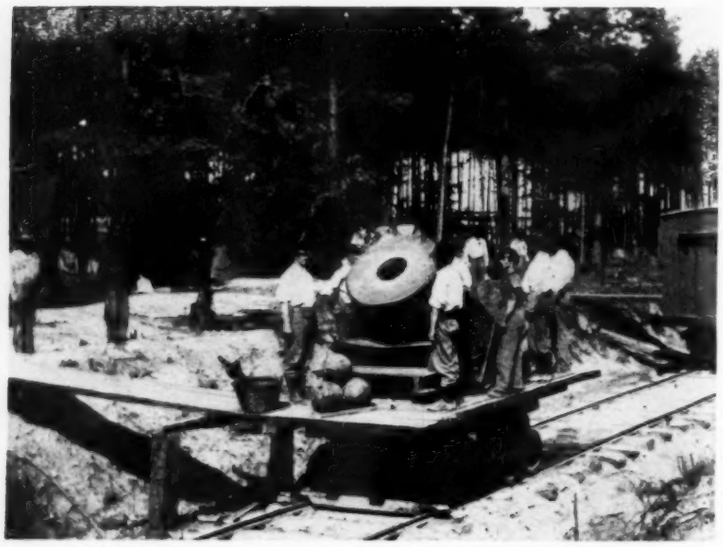
During the absence of these committees the meeting was given over to an informal discussion of plans for a first meeting of the post for the presentation of the charter.

The constitution committee reported a constitution which was unanimously adopted. The nominating committee presented the following nominations: for president, Col. Wm. W. Coleman; for vice-president, Maj. Eric H. Lichtenberg; for secretary-treasurer, Capt. George H. Boyer; for director for two years, Herbert V. Kohler; and for directors for one year, Wm. Horlick, Jr., and Lt. Col. James G. Cowling. The temporary chairman was instructed to cast one ballot for these names, which he did, and declared them duly elected.

Colonel Coleman then took the chair and made a brief address which was greeted with considerable applause. It was then unanimously resolved that he be appointed a committee of one, with full power to negotiate with the Association and the Ordnance Department for the attendance of representatives of theirs at the charter meeting. He suggested that the date of this be November 23rd. The meeting then adjourned.

The Milwaukee Post embraces territory formerly a part of the Chicago Post of the Army Ordnance Association. All members of the national Association resident in the State of Wisconsin and that part of Michigan contiguous thereto are eligible to affiliate with the Milwaukee Post.

Ordnance in the American Civil War

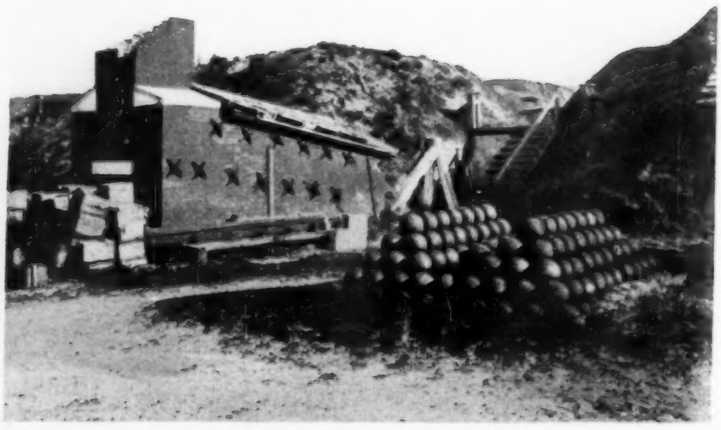


Forerunner of Railway Artillery.

Just as the American Civil War produced the first ironclad, so, it seems, this mortar mounted on a railway truck is a prototype of the railway guns of today.

The Defense of Washington.

Scene at one of the forts near the Capital during the Civil War. The effect of the machine age on gun mounts can be visualized from the carriages of the pieces used only 65 years ago.



A Hot Shot Factory.

Furnaces of this type were to be found in many forts of Civil War days. In them ball ammunition was heated before firing thus adding warmth to the greeting. Hot shot was first used by the British during the siege of Gibraltar (1779-1783) when, by this means, the defenders of the fortress set on fire the attacking force of French and Spanish ships.

Procurement of Noncommercial Material in Time of War

By R. R. Nix*

THE fighting power of a nation cannot be measured solely by the output of its manufacturers. Were such the case, using steel as an example, America could feel safe against the rest of the world combined—with a ten per cent factor of safety. The great power of American industries is known the world around. The importance of industrial power in modern warfare is equally well recognized. But wars are not fought altogether with such commodities as rails and copper and cotton and by-products of coal. Rail mills have to be converted to roll projectile billets, copper has to be formed into rotating bands, cotton converted into powder, and toluol into high explosives. The gradations of these transformations of commodities into munitions range from such technical articles as ammunition and ordnance weapons to supplies which differ little from those on the market, as uniforms, shoes and clothing. The object of procurement planning is to arrange for these transformations in the shortest possible time, in other words, to render the great potential power of American industry promptly effective in war. With this assurance provided and with her incomparable man power America can have no better guarantee of peace.

Obviously the most difficult problem which confronts us in providing this assurance is to arrange for the procurement of the technical items which have no commercial counterpart. Such articles normally are not produced in time of peace, are usually difficult of fabrication, and sometimes involve processes which are unknown to peace-time industry. Searchlights for the Engineer Corps, gas masks for the Chemical Warfare Service and military airplanes for the Air Corps either fall within this category or are semicommercial in character. In any event they involve great difficulty in procurement in the quantity demanded in war. Since the ordnance problem is confined almost exclusively to the procurement of strictly noncommercial material the subject of this article will be treated largely from an ordnance standpoint. The principles, policies and objectives announced are in general common to all supply branches as far as the procurement of this technical class of material is concerned. It is also a fact that the material produced by the Ordnance Department demands an exactitude of fabrication and a production in such quantity that the problem of planning in advance for its efficient production becomes one of our most important peace-time considerations.

LET us visualize the problem faced by the Ordnance Department in time of peace in making preparations to meet war-time responsibilities. To decide on the ways and means for solution, it is first necessary to determine the nature and scope of the problem. A consideration of the requirements of the military program of the War Department is the only practicable definition of the nature and scope of the problem and, as a consequence, an estimate of requirements forms the initial point of departure in all war plans.

All our material procurement plans hinge on the computation of requirements. Before any production can be scheduled we must know what we need and in what quantity. In turn, the requirements computations depend on the following data: rate of man-power mobilization, employment of troops, tables of organization and allowances and such other factors as wastage and rates of fire.

With the foregoing data the material requirements may be computed. The Ordnance Department has computed the requirements for 1,200 items of issue, this number covering the field in typical fashion, involving over 95 per cent of the funds which would be required for the ordnance program. Of course, the number of issue items computed does not cover the whole field. Each item must be broken down and traced back through its components and semi-finished material to the mine and the forest before the requirements task is completed. This study involves requirements for the many basic materials which enter into an item of issue and forms a continuing study for future years. Many of the basic materials present peculiar problems all their own because they are strategic—such as nickel, manganese and tungsten.

It is important to emphasize here the need for developing a flexible scheme for computing requirements so that they may be determined with facility to meet the fluctuating conditions of an emergency.

AFTER requirements have been established, the next step is to develop plans for the procurement of the materials needed. Such plans involve a variety of considerations, the most outstanding of which will be noted.

The first question which arises is one of organization. The peace-time organization is so constructed that the transition from peace to war is one of expansion, not of reorganization. Previously assigned reserve officers will be called in successive echelons to fill positions in the peace-time skeleton organization until the full development is attained. Civilians for key positions are also listed for call when needed. For M Day there remains only the problem of recruiting civilians for clerical positions in the organization, a task which should be easy of performance since there should be no shortage of such personnel. There are so many advantages to expansion from the peace-time organization by absorption that it is needless to dwell further on the subject.

Another cardinal principle recognized in the organization plans of the Ordnance Department is that of decentralization. The ordnance problem is of such magnitude that it will be impossible to attempt the procurement of the thousands of items required from a central office in Washington. At the outset of the last war the Ordnance Department

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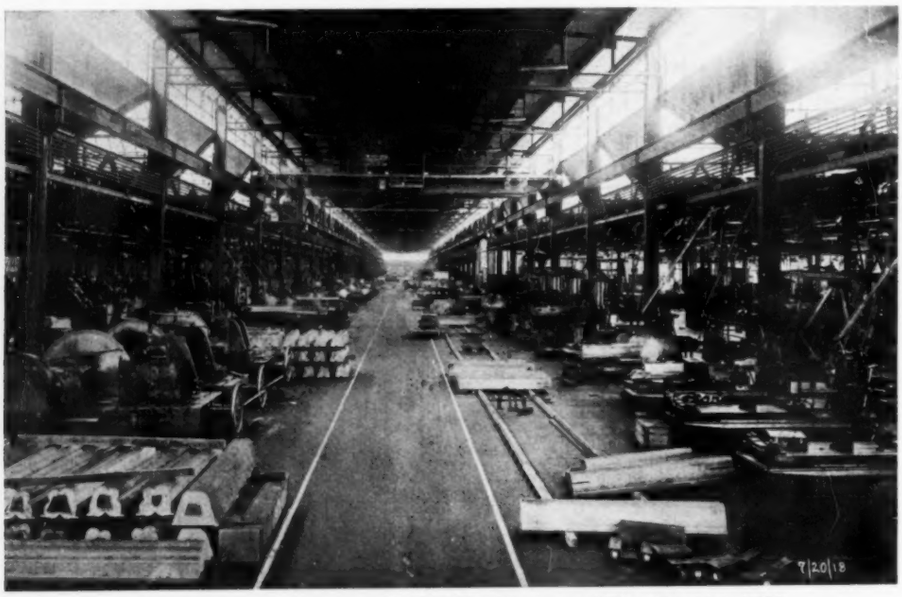
actually attempted to procure all of its material from Washington but the problem so outgrew the Washington force that decentralization to territorial districts was the logical result. Our district organization fulfilled its purpose during the war and the inference was natural that if established in time of peace it could again assume the burden in case another war should become necessary. These districts are the same as the War Department Procurement Districts and are engaged at present in war planning activities for the procurement of material. In time of war



An Automobile Plant Engaged in the Manufacture of Recuperators, 1918.

it would be the duty of the ordnance districts to expand in conformity with definite plans from the existing skeleton force to a war basis and care for the different Ordnance Department functions incident to the procurement of the material assigned to the district. By means of the district system, we believe that we are accomplishing a decentralization which cannot fail to simplify the problem of procurement in time of war and to insure the supply of the necessary munitions when and where needed.

SOUND organization is the first question which should be decided in time of peace by the Ordnance Department. There are other phases of the problem of almost equal importance. Perhaps the phase which is demanding the greatest attention in our present plans is that of the designs of the articles which would be provided for the troops under a war procurement program. The history of the World War is replete with examples of cases where changes in design produced a disastrous effect on the production of material. A classic instance occurred at the plant of one of our most successful producers of field gun shrapnel. This firm was given a contract at the outset of the war for the production of a 3-inch shrapnel and began the production of this item on scheduled time. Then came the decision to change the light field gun from the 3-inch type to the 75-mm. French type. The Ordnance Department immediately took steps to turn over the production of 3-inch shrapnel at this plant to that of 75-mm. shrapnel. The only difference between the 3-inch shrapnel case and that of the 75-mm. shrapnel is a minor change in the machining process. The plant made extensive plans to change over with a minimum of delay but so demoralizing was the effect of this change, minor as it was, that before the plant could get its operators trained to the new dimensions, nine full days of production had been lost. This is an example of the effect of a minor change on a production program. The effect of other more radical changes of design which developed as the war progressed can well be imagined. The shutting down of the Ford plant for more than six months is a good recent example in the commercial world.

With this lesson in mind, we are taking steps in time of peace to settle on a standard design for each item to be produced for the troops in time of war. It would be our purpose to place this design in production at the outset of the war and then give consideration to a possible rearmament program with a better type later. Such a rearmament program would require the maintenance of the production of the original standard model until the new design could be gradually brought into production by use of other facilities. The original production of the standard model would then be tapered off as the newer type increased in rate of production and the latter would be supplied to troops as rapidly as possible. Of course it would be necessary to continue the old standard in production for maintenance purposes as long as any of the type remained in the hands of the troops, but it would be our plan to give the troops a new and improved weapon as quickly as possible without impairment of the supply of the older model in the interim of nearly two years before sufficient numbers of the new type could become available.

Another important feature of our plans is the insurance that drawings and specifications for the standard designs are on hand and are up-to-date. It goes without saying that any procurement program would be impossible without these essentials for manufacture. The drawings are, as a general rule, on hand, but the specifications require further work. It is our desire to have a post-war specification for every standard item and we are making substantial progress in that direction.

AS time passes many of the personnel who gained valuable experience in war production are being scattered and, in fact, many have since died. Within a few years knowledge of munitions production in civil life will be lost completely by this process of attrition. It therefore becomes an essential feature of procurement planning to insure that a careful record is kept of the methods of manufacture for noncommercial items which were found to be successful in the last war. The Ordnance Department is

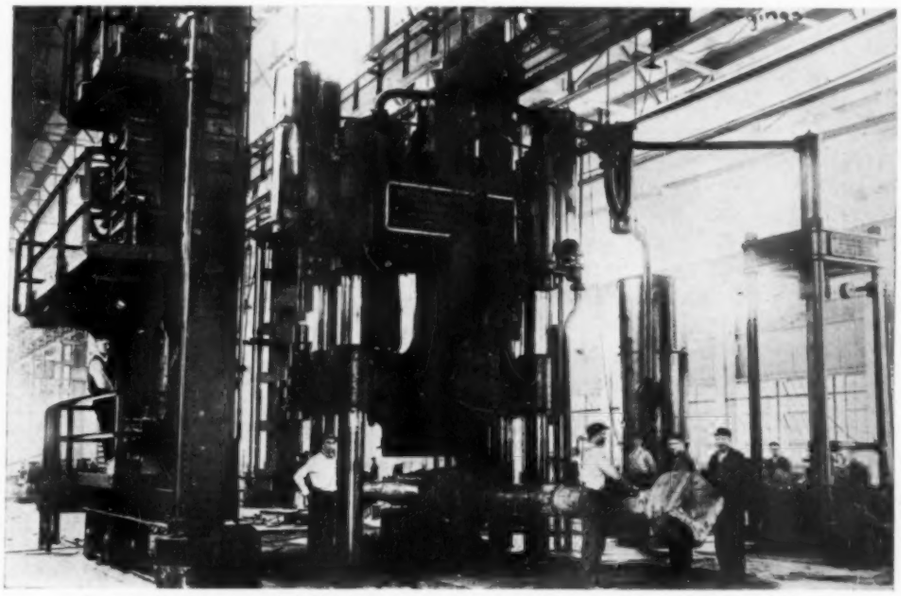
engaged in collecting and putting into book form successful methods of manufacture. It is believed that by having this information on hand it will be possible to start the war manufacturer of some years hence with full information covering the technical features of the problem with which he is expected to cope.

This phase of our plans is considered by many manufacturers who had war experience as one of the most important planning activities in which we are engaged. It is so important that it warrants going into the subject more fully. Take the case of a manufacturer who is engaged in the production of drawn brass articles as a normal peace-time activity. We go to him in time of peace with the information that we expect him to produce 15,000 brass cartridge cases per day in time of war and ask him to make a factory plan. He wonders how much it will cost him to prepare such a plan and perhaps decides that he cannot afford the expense. This does not help our plans very much if we have not other resources to marshal for his assistance. His wonder about costs will disappear at once if a book showing a desirable method of manufacture is then produced. In it he will find a detailed description of the operations, a list of machinery required, a complete plant lay-out, data on personnel, power and raw material requirements, and many other useful details. He would note at once the variations from the standard scheme which would have to be made to accommodate his own plant, and could specify his requirements for machine tools and other necessary aids to manufacture. His factory plan would be relatively simple of solution and would entail little, if any, expense. He might even file a standard method without change if new facilities for the particular item should be necessary. Again, it might be necessary after war was declared to go for cartridge cases to a manufacturer who had not, for some reason, made any peace-time plans. If we could present to him along with the drawings and specifications, a book showing the methods, it might safely be said that an inertia and experimental period of two months on a cartridge case order would be eliminated. The manufacturer would probably flounder in a maze of experimentation for such a period in search for the best way to turn out this simple item in quantity. A carefully compiled method would be a life-saver under such circumstances, particularly since time is of the essence in war and little of it can be spared for experimentation on methods.

The Ordnance Department has recently organized a committee of outstanding manufacturers to review its typical plans for shell forging and machining. It is expected thereby that the best methods and practices throughout industry will be incorporated in these and similar plans.

In this connection it is hoped that the bills now before both houses of Congress relating to educational orders will soon become law. In no way can procurement planning for noncommercial items be better advanced than by distributing small orders throughout American industry to educate a reasonable number of our commercial plants in the art of making the latest types of munitions.

IF one asked a foreigner to express an opinion as to the most outstanding feature of American industry, he would probably answer that the mass production so common in American factories is to him the feature of the greatest interest. Mass production is unusual in European factories, much of the work being done by skilled artisans who have learned a definite phase of production by long experience and actually fabricate each article without reference to possible interchangeability in assemblies with other articles of the same kind already manufactured. Mass production in the United States is directly due to the development of the art of interchangeable manufacture. Interchangeable manufacture, in its turn, is made possible by the use of gages. Gages are simply precision instruments for insuring that every piece turned out in a given operation is exactly like every other piece. By the use of such instruments any piece going to make up the whole can be inserted in its proper place in any assembly without impairing the functioning of the finished article. A valve for a Ford car bought over the counter will fit perfectly in any Ford engine. This would not be true if gages to insure uniformity were not used in their manufacture.



Press of a Commercial Steel Plant for Manufacture of Gun Forgings, 1918.

In time of war, quantity production of munitions is an important factor in securing an early decision, especially since the outcome of modern war is so largely dependent on the munitions power of the respective belligerents. Since munitions power is so important it is pertinent to the issue to examine into the relation of gages to a program for the development of such power. It is not argued that munitions cannot be made without gages, since the French demonstrated during the war that it could be done. Other

measuring instruments can be brought into play but the rate of production will always be much less than that which would be attained with the proper complement of gages.

Our plans for the next war contemplate thorough preparation to insure a supply of gages in order that mass production may be secured as rapidly as possible. Such a program involves a considerable problem, the high points of which will be outlined. We have on hand as a war reserve nearly half a million ordnance gages which became the property of the Government after the World War. The gages are carefully catalogued and stored in the various arsenals. Theoretically they form a stock which we could issue immediately to manufacturers to tide over the gap until production of gages could be secured. But our gage stocks have disadvantages. Miscellaneous designs, unbalanced sets, and other elements decrease the value of the war reserve stocks as a stop-gap for the early months of an emergency. We are, however, attempting to round out in the war reserve complete sets of gages for the quantity production of the ordnance material normally carried by an infantry division. A beginning is being made on this project at the present time using current appropriations, for which Congress has recognized the need.

For divisional matériel the Ordnance Department has established the requirements and knows the composition of the gage sets necessary for war production on a six-army program. The next step is to determine where the gages will be secured. The large gage manufacturers are, of course, the natural sources and are willing to take on war orders. But these manufacturers are definitely limited by the number of gagemakers in the country. Gagemaking is the highest form of the toolmaker's art. In fact, the gap between a toolmaker and a gagemaker is almost as great as that between a house painter and a portrait artist. The gagemaker must possess infinite patience and skill since he is working with dimensions expressed in thousandths of an inch. The slightest slip of his tool may ruin the work of a month. Some gages require the services of a gagemaker for such a period for their completion. By reason of the special qualifications necessary it is natural that there are not very many gagemakers in the country. In fact, it is said that there are only about 30,000 in all, and it is probably also true that not 10 per cent of this number could qualify as artists in the work. In the circumstances, the supply of gagemakers is the limiting factor in the production of gages. If the manufacturer having an order for gages should, for any reason, lose any of his gagemakers, he probably could not replace them and his output would be curtailed accordingly. So far as the Ordnance Department is concerned, the solution of the gage problem lies in the proper distribution of gage-making personnel, their exemption from the draft, and the possible development from intelligent toolmakers of additional gagemakers during the emergency. By proper handling, it is believed that all three of these factors could be solved and that gages could be made before the factories to use them could finish their conversion to war production.

THE quantity production of munitions would be impossible without machine tools. Our country is well provided with the standard machine tools required for commercial industry. Each industry also has its complement of special machine tools in adequate numbers. But when we approach industry for the production of noncommercial items in large numbers, the supply of the special purpose machine tools which are so necessary for mass production becomes a critical issue. In fact, the supply of such tools would probably be the factor limiting the time when mass production could be obtained. Machine tools of special design normally require months for their fabrication in time of peace, and it is reasonable to assume that in the confusion of war conditions the time required would be lengthened.

The machine tool problem is engaging our attention at the present time. We are securing the requirements of the various types needed by all supply branches in the War Department Commodity Committee on Machine Tools, and it is our intention to advise eventually the Machine Tool Builders Association of our needs with the request that the Association recommend the firms from whom the tools should be obtained. The next step will be to approach the designated firms with accepted schedules of production. Particularly will it be necessary to supply these firms with as much information on the special purpose designs as can be assembled. There is a considerable quantity of information on these designs on hand which, if assimilated into proper factory plans by machine tool builders, will exercise a considerable influence on the time necessary to provide such tools in time of war.

NO program for the procurement of noncommercial items can be carried on without money, and government money must come from Congress. Appropriation Acts in 1917 carrying adequate funds did not materialize until October of that year and such procurement as was carried on in the meantime was handicapped at every step by the uncertainty of the supply of money. The effects of this delay during the World War can be evaluated approximately in the statement that we probably could have reached our maximum peak two months sooner if the uncertainty concerning appropriations had been relieved immediately after the declaration of war.

Consequently it is of great importance to secure promptly from Congress the funds necessary to carry on production. We can do our part in this problem by preparing in time of peace our estimates for funds. This estimate can be worked out more or less completely since it is dependent only on studies which can be made by the Ordnance Department from war plans already completed. We have such a study at the present time and could submit it within 24 hours as a preliminary estimate. The detailed defense could then follow before the appropriations committees.

Once the foregoing steps have been undertaken for any major item of ordnance, it is put in the form of a specific procurement plan. These plans are submitted currently to the Office of the Assistant Secretary of War and give a comprehensive report of the progress on procurement planning for the item or group of items concerned. It should be noted that specific procurement plans for noncommercial items involve a great many laborious steps particularly in factory plans not necessary for commercial articles.

ENOUGH has been said so far to indicate that noncommercial items are difficult to procure and that, because of varying limiting factors, an appreciable period must elapse before industry can be converted to produce such

items in quantity. In fact, it is almost axiomatic that quantity production of most noncommercial items will require a year for development. This being the case, it is necessary in time of peace to hold stocks of munitions to tide over the period until new production can be secured. Such stocks constitute the war reserves.

The World War left us with large stocks of munitions which were, in the interests of retrenchment, reduced materially by salvaging processes after the war. There were withheld from salvage ample stocks of important items to constitute war reserves. Principal among these items were the various types of artillery ammunition and all of our artillery stocks. We now find that we are facing larger maintenance charges for the proper upkeep and turnover of these stocks than we can hope to obtain from Congress in the annual appropriation acts. Particularly is this true of ammunition where deterioration plays such an important part. An annual appropriation of $17,000,000 would be required to keep up our authorized ammunition reserves alone and this is $6,000,000 more than we are getting for all purposes in the annual budget. While we believe that the required financial outlay is a modest premium on a good insurance policy, it is at the same time realized that the retrenchment policy of the Government will probably prevent for some years to come the appropriation of the necessary funds.

UNDER normal peace conditions we have only six arsenals and two nitrate plants capable of the early production of about 5 per cent of the necessary munitions. The question might then arise as to the necessity for considering the arsenals at all in the production of the noncommercial items which they can turn out, particularly since the quantities would approximate only 5 per cent of the demand. The answer is simply expressed. The arsenals have an important place in time of peace as centers for the art of munitions making. If we did not have the arsenals, the art would speedily die out. They also serve as technical centers for our district planning, giving assistance on the technical phases of the peace-time planning activities when called upon. In time of war the arsenals will produce as quickly as possible the war orders which we have given them and, while the quantity will not be great, the effect of their output, if early, may be of utmost importance. Of more importance will be the training functions of these establishments in time of war. Inspectors for the bulk of the production coming from commercial industry will be trained at appropriate arsenals. Personnel from war manufacturer's plants will be received for training in methods of manufacture. Technical information will be prepared and disseminated to war contractors. Difficulties in manufacture will be studied and solved for the manufacturer. In short, the arsenal will be expected to aid in every way the main production program for industry and at the same time to turn out such quantities of munitions as may be possible without extension of present facilities.

Briefly, the procurement of noncommercial materials in war presents the most serious problems in industrial planning. While efforts are being made to secure additional personnel for the supply branches for this work great energy should continually be directed to secure funds for adequate war reserves and for educational orders. It is believed that for no other item in the whole budget of national expenditure could so small a sum be more profitably invested for the security of the Nation, the advancement of national defense and the assurance of peace.

The Big Bertha at Aberdeen.

The only assembled weapon in the United States of the type used against Belgian fortifications by the Germans. This huge trophy is permanently emplaced near the entrance to the Aberdeen Proving Ground, Md.

Power in Industrial Mobilization

By B. C. Dunn*

POWER or energy may be considered as a basic raw material which enters into the fabrication of several hundred thousand components of articles required by our armed forces to participate in present day warfare. Power, labor and transportation are the three industrial graces so intimately connected with war, and not the least important of these is power. Without it the wheels of industry remain idle.

The ability of a nation to manufacture munitions of war, largely determines its mobilization rate. As demonstrated in the recent conflict the material side of warfare has an important bearing upon the issue; men can be mobilized and trained at a faster rate than human and mechanical energy can convert raw materials into arms and equipment.

Electrical power is the form in which power is most readily available and most valuable in industrial enterprises. Power does not pertain to any single branch of the Government or to any single procurement program. It is as essential in the manufacture of surveying instruments as in the manufacture of artillery ammunition, but in varying amounts. The essentiality of an adequate supply of power depends, therefore, on the essentiality of the article to be manufactured.

The production capacity of the average American due to the use of electrical and mechanical power, is thirty times as much as that of the average Chinaman, about twelve times that of the Russian and two to three times that of the European. Every kilowatt of power installed in our central stations, every auto truck and tractor, even every mule, enables the United States to meet a war emergency with greater efficacy. Power is behind them all. It releases men for the fighting line by reducing the number of men required to produce our munitions, our food and our ordinary necessaries of life.

DURING the period of the World War the kilowatt hour output of industry was increased from sixteen to twenty-nine billion, and notwithstanding this rather extraordinary increase of 75 per cent, certain industrial sections experienced shortages, notably the following districts: Niagara Falls, Pittsburgh and neighboring cities, the New England states, New Jersey, Philadelphia and Easton, Pa., Baltimore, Md., Wilmington, Del., the Pacific Coast and several localities in the southern states. The essential causes of these shortages as determined by the power section of the War Industries Board may be summed up as: (1) shortage of fuel, principally caused by lack of storage and in some degree by deficient railroad transportation and inadequate production; (2) shortages of water power, due to adverse weather conditions; (3) lack of capacity of central electric power plants to meet the extraordinary war demand; (4) greatly increased cost of operation, appliances and construction; (5) delay in getting machinery and supplies; (6) selling price of product fixed by regulation, and (7) difficulty of obtaining necessary funds.

In meeting the conditions of inadequacy the power section had to contrive ways and means under rather trying circumstances owing to lack of information as to power requirements and sources, lack of a trained war organization to assume war control and lack of coördination of fuel, labor, power and transportation. Just prior to the Armistice, the situation had reached the state where the War Industries Board was urging Congress to appropriate $200,000,000 to aid the power companies in meeting the industrial demands. The power shortage which existed in the chief industrial centers due principally to ineffective interconnection arrangements and financial stringency, as relating to the industry itself, was alleviated by certain curtailments of the less important industries but had not the Armistice been declared, it is generally admitted that the shortage in 1919 would have been even more critical. These conditions existed in spite of the coöperative spirit and willingness of the electrical industry to furnish super power and super patriotism.

THE electric power industry has increased enormously since the World War. In 1918 the installed central station power was about nine million kilowatts and in 1926 was about twenty-three million kilowatts. There has been a corresponding change in the utilization of power. In 1919 electric power furnished 55 per cent. of the motive power of American industry, while today it furnishes about 75 per cent. The 25 per cent. of mechanical power still remaining is almost entirely confined to special applications or very small ones. Although there has been a small increase in the amount of power generated for individual use, most of the decrease in mechanical power has been absorbed by the central station industry. Now nearly half of the total power of the country comes from central stations. In 1918 about thirty billion kw.-hours of electric energy were utilized in the United States and in 1927 about eighty billion kw.-hours.

The increasing demand for power in all industries, together with the high cost of coal and the serious interruptions in its supply due to recurring labor difficulties, have produced a very marked increase in the development of water power for prime movers which has reached nearly 40 per cent of the total prime mover power. However, during the last few years the relative gain of water power on steam power has been decreasing. To some extent this is due to the interference of political considerations but the chief reason has been the great strides in the economy of steam plants which have made hydro-electric possibilities less desirable. There is still much room for extensive hydro installations but the intrusion of polities and the probable development of the more attractive projects in the near future will probably cause a considerable restriction in the hydro-electric field. In favorable cases steam plants can now successfully compete with the better of the hydro

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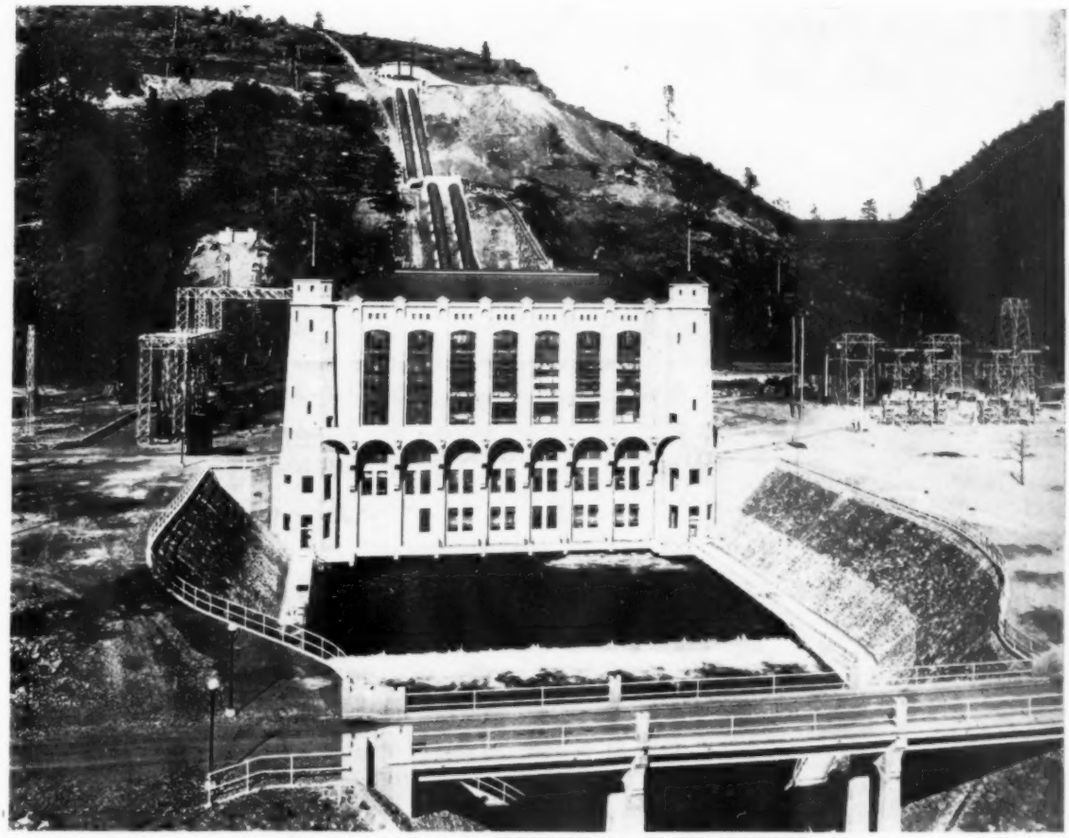


An Hydro-Electric Power Plant of the Pacific Coast Area.

plants. The average fuel consumption per kw.-hour has been reduced from 3.2 pounds in 1919 to 1.8 pounds in 1927 with the end not yet in sight. Some plants use as little as 0.8 pounds per kw.-hour. These improvements in economy are proceeding very rapidly. Two and a half billion kw.-hours more of electric power were generated by steam in 1927, than 1926, using 150,000 tons less fuel.

The widespread use of electric power has greatly extended the transmission systems and led to extensive use of interconnections between different systems. Numerous large-sized economical base-load steam plants have been constructed near the great load centers. Nearly all the important industrial areas east of the Mississippi are now so interconnected that there is a united net work reaching from Maine to the Gulf and from the Mississippi to the Atlantic seaboard. The same is true of the Pacific Coast west of the Coast ranges.

The great importance of the power industry and the large sums involved in new installations and extensions have led to great consolidation. This is going on very rapidly; during 1927 there were over eight hundred changes of the corporate nature of power companies. Smaller companies are being absorbed by larger ones and the large companies are coming under the control of great holding corporations. This has brought about increased flexibility through interconnection of transmission systems and more centralized control.

The growing dependence of industry on central station power is an asset for war. The extensive transmission systems, their many interconnections, and the consolidations make the power supply very flexible and more simple of control. This has also produced a noticeable tendency for industries to leave present congested areas for new and uncongested ones. The increase in hydro-electric power and the great economy of the modern steam plant produce enormous savings in fuel. Hydro developments conserve labor as well as fuel and transportation and therefore should receive maximum encouragement. The substitution of the large central power plants for small individual ones simplifies the problem of fuel distribution.

On the other hand, there is probably less relative reserve in the modern power industry. The chief object of interconnection of systems is the raising of the load factor. This automatically reduces the reserve capacity. Also the mere vastness of the industry makes its control a tremendous job.

ARMY and Navy industrial engineers, civilian power experts and others who have given the matter serious consideration, realize that in preparation for the next war the Nation must be prepared to meet a power demand greatly increased over normal requirements. In 1930 the normal electric energy demand may well be 100,000,000,000 kilowatt hours which is four times that of 1917 and six times that of 1914. The magnitude of a future abnormal war load is rather difficult to predict but notwithstanding our phenomenal growth during the past decade, the energy situation will undoubtedly find itself as strained as it was during the last emergency.

Military authorities in Europe predicted that the World War would be of short duration; that men were needed more in armies than in factories and that the consumption of munitions, and especially ammunition, would be approxi-

mately one-tenth what it actually was. Many other incorrect prognostications could be listed but are unnecessary to prove the point that what form the next war will take, with its consequent drain upon mechanical energy, will remain a mystery until the actual happening of that unhappy event.

War is speed and the time element is essential. In looking back to 1917 we find ourselves fighting the "no plans" war. Important decisions were lacking months after declaration of war. This naturally retarded industrial adjustment, but it did give the providers of power an opportunity to prepare for the worst. Now, however, plans are available to place the military and supply machines in motion promptly, and the sudden release of billions of dollars of equipment orders will be the first warning to power producers and others to limit nonessentials and proceed with all available speed to execute war orders.

By rule of thumb power requirements are roughly proportional to ammunition needs which in turn appear to increase fivefold with each succeeding major conflict. Mechanization of the Army is proceeding at a rapid rate and this variation in the make-up of fighting forces calls for large additional blocks of power at every turn. It is conceivable that the next great call, the outlawing of war notwithstanding, will require from five to ten times the energy consumed in 1917.

ALL of the supply branches of the Army are charged by law with the procurement of supplies and equipment of one type or another. When a contracting officer places an order for the finished product he will not in general know where all the raw and semifinished products going into the finished product will be procured and it is not in general necessary that he should know. In the vast majority of the items of equipment and supplies required—considering the *number* of items only—it would be fruitless to attempt to trace back to the origin the energy consumed in the manufacture of all the component parts. Besides, it is entirely impracticable to attempt to have the manufacturers with whom accepted schedules of production are placed, furnish that information. They, themselves, do not know. On the other hand, there are certain items in the procurement schedule of each branch which are enormous in quantity and in the power required to produce them. The manufacture of these at a rapid rate will throw an enormous load upon the electrical central stations of the country. Thus, in the program for 3-inch shells the power required in the processes of forging, machining and loading is considerable. It would therefore, in itself, throw an appreciable load upon the power stations of the districts in which the orders are placed. The energy required per thousand shells in each of the processes involved and the power—that is, the installed horse power and the maximum load for the plant as a whole—required for any new plant or expansion of existing plant should be carefully investigated. It is absolutely essential in the preparation of a factory plan involving new or expanded facilities or in one in which the maximum electrical load is to be increased appreciably due to the war order, that the power problem be considered and the added load in terms both of energy consumption per month and of maximum power load—be stated.

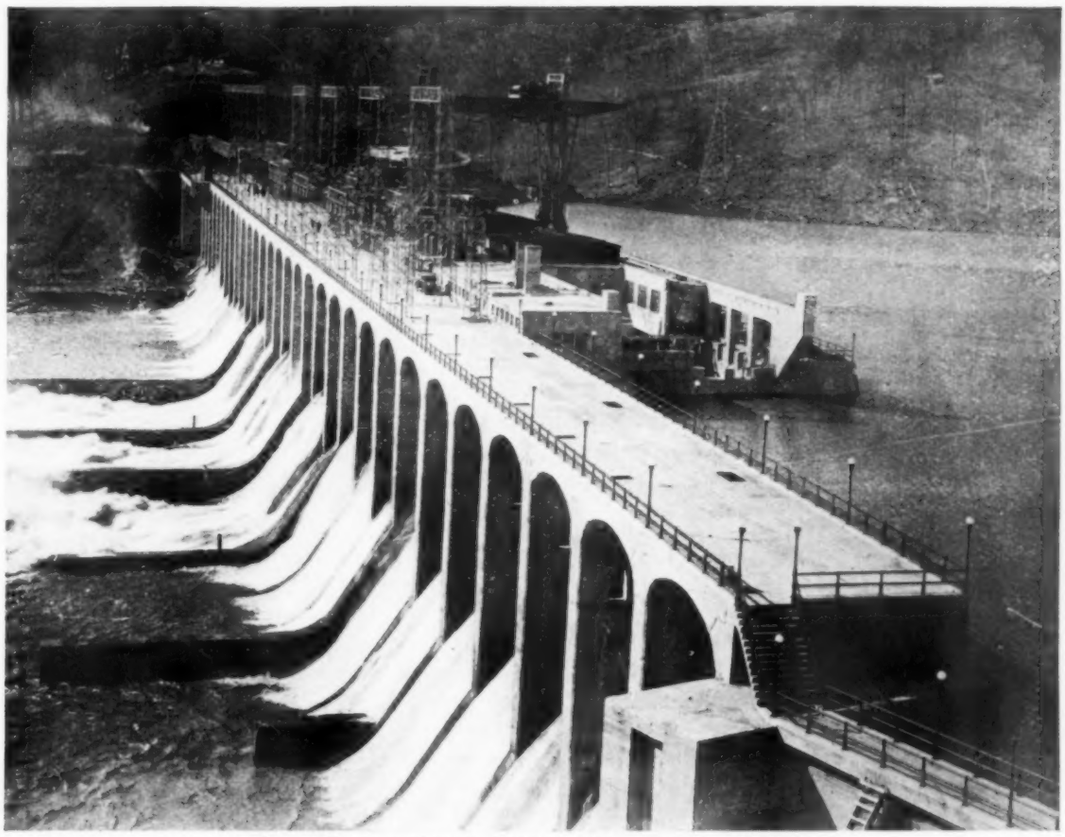
The aim of the supply branches which require power directly for their own needs or for the factories that are manufacturing products for them, should be to place themselves in a position on M Day to say to an emergency power director or his representative, "The load that will be thrown upon the central station at X—— due to the orders we have placed will increase the load by —— kw. We will need —— kw. at the Jones Plant in Z—— on M plus 2, —— kw. at the Smith Plant in Y—— on M plus 3, etc. Can you get it for us?" It will be the duty of the emergency power director, who of course can count upon the loyal support of the industry, to get it there if it is humanly possible. He will get it by means of interconnection with other systems that are not so heavily loaded, by increasing the capacity of plants in the district, by restricting use of power for advertising and excessive illuminating purposes and by curtailing the use in nonessential industries when authorized to do so by the President.

Under the provisions of the National Defense Act the Assistant Secretary of War has been designated the business manager for the War Department, and it is his duty to supervise the procurement of all military supplies. In connection with other industrial mobilization studies, he is having a careful survey made of the power industry and is making every effort to encourage expansion, interconnection and consolidation of utilities.

IN planning for the control of power in war, it is essential to know what we have in the way of power and its installations. This knowledge is of even more importance to the agency which will control power in war. This information is being gathered by the Corps of Engineers in an annual power survey.

In brief the power survey consists of an investigation of all central electrical generating stations and systems with a capacity of five thousand kilowatts or over. The survey is made by the district engineers in charge of river and harbor districts. There are some 42 of these located in the principal cities of the United States. The reports of the district engineers, with maps, showing the location of the generating plants, the capacity, the annual production of electrical energy, the transmission lines and principal substations, together with information as to the phase, voltage, frequency and capacity of the transmission line, are submitted to one of eleven officers, each placed in charge of one of the power zones into which the United States has been divided. These zones were made up to conform as closely as possible to our War Department Procurement Districts and still be of a size permitting easy administration. The boundaries were laid out so that a minimum of power crossed the boundary. The complete reports of each of the officers in charge of the zone surveys are submitted annually to the Chief of Engineers and then consolidated and filed for use of the Assistant Secretary of War.

Through the medium of the power survey the Assistant Secretary learns of the power resources of the country. His second task is that of balancing the power load against these resources in a manner to assure adequate power for the essential industries. Upon this second part of the problem, progress has not been as satisfactory as upon the first part. The reason for this lies in the fact that the power required by the various facilities at which accepted schedules of production are to be placed, cannot and should not be determined until the time those schedules are actually placed. In the summer of 1927 a study was made of one



Mitchell Dam, an Hydro-Electric Development in Alabama.

of the power zones. At that time only 50 per cent of the money value of the expected war load in that district had been placed. It is evident, therefore, that the total power requirements in any zone are not yet available. However, as the direct load placed upon any district by the War Department bears a small ratio to the total manufacturing load in the district, it is apparent that we will never obtain the total war load in a district by merely adding the power required to carry out our primary contracts, or even our subcontracts. We can, however, determine in time of peace the amounts of power required by each facility to carry out its accepted schedule of production.

This problem, in itself, is one of some magnitude. However, it may be approached in a reasonable manner much in the way it was tackled in the World War. The Power Section in the War, in Priority Circular Number 45, issued instructions that consumers having a connected load of one hundred horse power or less would not have their demand curtailed except under very exceptional circumstances. The saving of electrical energy through a curtailment of these small consumers would not justify the loss, damage, inconvenience and industrial disturbance that would follow. In the same way our supply branches will soon be called upon to submit statements showing the connected electric load (in kilowatts) and the monthly consumption (in kilowatt hours) required to meet the accepted schedules of production placed with each facility. From this requirement will be exempted all those facilities having a connected load of less than 100 kilowatts or a consumption of electrical energy of less than ten thousand kilowatt hours per month. These reports will be consolidated in the Office of the Assistant Secretary of War by cities and power zones and furnished to the officers in charge of the power zones. These requirements can then be matched against the actual resources by localities in each of the power zones. In the great majority of the cases it will be found that the supply is quite adequate to meet the expected demand, as shown by these figures. In certain cases, however, an excess will be indicated, which will require detailed study in the power zones to assure that the facilities receive the amount of power required.

This detailed information really represents the goal we are striving for. With information as to resources and as to demand in usable form, generally plans will be altered if any shortage is indicated. On the other hand, if it is impossible to place orders elsewhere then the situation is clear as to what action must be taken in time of war. It is the basic data upon which any control of power must depend. Months of time will be saved and, in general, shortages of power will be eliminated before they occur. It is possible that no drastic control will be required. However, the indirect demand and the unknown elements in the problem are so great that a plan for a control agency is deemed necessary.

WITH this in mind a plan for the control of the power industry in time of war was prepared in 1926. It was submitted to the central station industry for comment. After the comments had been carefully considered and incorporated it was presented to the National Electric Light Association—which Association represents almost 100 per cent of the central station industry—by the Secretary of

War in an address on June 9, 1927. Definite action approving this plan has not yet been taken by the National Electric Light Association, but its early action is expected.

This plan, as explained by the Secretary in his address, is based on five general principles, as follows:

"(1) The Government should not take over any plant or power system unless necessary to insure the efficient prosecution of the war.

"(2) No additional control should be exercised in regions where power is adequate for present and immediate future needs, both civil and military.

"(3) When shortage of power for essential needs exists or is threatened, the Government should take over the entire output of the plant or plants in the locality and apportion the power output to users in the best interests of the United States. This action should set aside all existing contracts for the supply of power with which such action conflicts.

"(4) If the preceding methods fail to obtain sufficient amounts of power, the Government should undertake actual operation of such plant or plants.

"(5) The existing organizations of any companies taken over should be utilized in their operation, in order to make full use of the experience, training and skill of their personnel.

"With these principles in mind the plan calls for the selection by the President of an Executive Assistant, to be known as "The Emergency Power Director," who would be responsible for the effective utilization of the power facilities of the country. The Emergency Power Director would be assisted by an executive committee, the majority of the members of which would be nominated by the National Electric Light Association, and approved by the Emergency Power Director. These men would serve in a civilian or military capacity. The committee would serve under the direction of the Emergency Power Director and would be the medium through which the mobilization and coördination of the power systems would be carried out and effective coöperation secured.

"In case no Executive Assistant is appointed by the President, the Power Section of the office the Assistant Secretary of War will consider the needs of the Navy, Shipping Board, other Government departments, and civilians. This section will take over all power data from the Chief of Engineers. The chief of the Power Section will become the Federal Power Director and will organize his field force of Power Zone Directors from Engineer personnel and civilians. These field forces will be under the general administrative direction of the Chief of Engineers, in executing policies of the Assistant Secretary of War.

"In time of war the mission of the Power Section would be to supervise and coördinate the use of power in so far as it affects the munitions program, to maintain contact with other governmental agencies and industrial power interests, to pass on plans for expansions and new installations involving the use of large blocks of power, to advise as to the necessity for new electrical projects, priorities on large electrical equipment and upon the advisability of governmental financial assistance. In order to prepare itself in time of peace to carry out these highly important duties, contacts are maintained with the U. S. Geological Survey, the Federal Power Commission, the State Public Utility Commissions, the Corps of Engineers, National Electric Light Association, the Electric Power Club, *The Electrical World* and others.

"As stated recently by Mr. A. H. Markwart, Vice-President in charge of Engineering, Pacific Gas and Electric Company, 'the objective of the Service Companies is to assure an electric power supply having transmission and distribution flexibility essential and sufficient to meet the demand when an emergency arises. The policy of the public utilities of the country is to provide sufficient generating stations, steam or hydro, or both, connected to capacious distribution network through adequate transmission lines, with all of such facilities regionally integrated with respect to the territory served so that all industry therein may be assured of a dependable power supply.'

"For their World War effort, to provide service through 100 per cent coöperation and coördination, the electric power companies should be in line to receive some corporate form of the Distinguished Service Medal awarded certain individuals who rendered outstanding service. Since the Armistice that same patriotic spirit has been manifested in their willingness to supply the War Department with information, largely of a confidential nature, relating to their ability to produce and distribute. I wish to take this opportunity to express the appreciation of all those vitally interested in our national defense to these public-spirited utilities and to assure them that their remarkable post-war extensions, developments and consolidations, which have been brought about to meet economically our peace-time necessities, are daily placing our great Nation on a more substantial basis regarding the supply of that essential force for the preservation of life as well as permanent peace—power."

Army Board Recommends Caliber .276 for Semiautomatic Rifle

THE problem of a suitable semiautomatic rifle for use in the American Army advanced toward a satisfactory solution with the recent decision to adopt a specific caliber for the weapon. The development of a semiautomatic shoulder arm, in the opinion of the Chief of Ordnance, is one of the most important projects now before the Department. Experimental tests of several designs have been made with the result that the question of caliber of the weapon to be adopted has been determined.

A board of officers, headed by Col. William H. Tschappat, Ordnance Department, and including Army, Navy, and Marine Corps members, to recommend a specific caliber for future development of the semiautomatic shoulder rifle and to perform other duties assigned in connection with tests of such weapons, has recommended that a caliber of .276 be adopted as a standard for the semiautomatic shoulder rifle to replace the present shoulder rifle caliber .30. The board further recommended that as soon as practicable tests be held of semiautomatic shoulder rifles caliber .276 for the purpose of selecting a suitable type of no greater weight than that of the present service rifle caliber .30. In the tests the ammunition to be used will have the following general characteristics: muzzle velocity—2700 feet per second; bullet weight—125 grains. The War Department has approved the recommendation of the board and has ordered the manufacture, subject to the availability of funds, of a sufficient number of semiautomatic shoulder rifles for extended tests by the several branches of the service.

The Army Industrial College

A New General Service School

By Irving J. Carr*

THE Army Industrial College—the most recent link in the chain of Army educational institutions—is unique and yet a thoroughly logical development. As a school devoted to the study of the economic aspects of war, it stands alone in the educational system of this country—both within as well as outside the service—and, for that matter, is probably the only institution of its kind in existence. That the establishment of such a school should be an inevitable result of the experience of the World War will be apparent when its purpose has been more fully explained.

Looking back to the World War period, it appears striking that no nation should have anticipated the importance of the industrial phases of such a conflict. The strictly military aspects of warfare, of course, had been studied intensively for many years; the subjects of organization, tactics and strategy had been thoroughly worked out; military men had been well grounded in the science and art of utilizing troops effectively in the field, but no one had visualized the industrial problems involved in mobilizing entire nations for war. With the experience of the World War came the realization that modern conflicts must be fought not only at the front but in the drafting rooms, in the mines and in the manufacturing plants, and that the efficiency with which these phases of the conflict are performed has a vital influence on the success of operations in the field. This realization, however, came too late to be effective even in this country for, to our dismay, we found in 1917 that our economic resources could not be converted to the national defense as rapidly as necessary for the support of our military forces and we, the greatest industrial nation in the world, were forced to rely on our allies for a supply of a large part of the most essential articles needed by our fighting men. It might be argued that these experiences, which have now become history, have left an indelible picture in the minds of our people and that no special effort is needed to assure that the economic aspects of a great war shall receive adequate consideration in preparing for the national defense. This may be true as regards those of the present generation who struggled with problems of supply during that critical period, but one needs only to turn to history to learn how quickly even the most bitter experiences fade from the public mind and how soon the lessons to be learned from them are forgotten by succeeding generations.

How then can we assure that these experiences shall not be forgotten 25 years hence—or 50 years? The establishment of the Army Industrial College goes far in answering this question, for it may be said that the primary purpose of the institution is to insure that, in the preparation of plans for the national defense, the new factor in warfare brought into prominence by the recent conflict—industry—shall receive the attention it deserves. The college is, therefore, a direct and necessary development of World War experience.

THE college has been in existence only five years but the idea of such an institution may be said to date from the passage of the National Defense Act in its amended form in 1920. This statute embodies the experience of the World War and, for the first time in our history, gives legislative recognition of the importance of the economic factor in war. Specifically, the Act provides that "The Assistant Secretary of War, under direction of the Secretary of War, shall be charged with supervision of the procurement of all military supplies and other business of the War Department pertaining thereto and the assurance of adequate provision for the mobilization of matériel and industrial organizations essential to war-time needs."

The Assistant Secretary of War, therefore, is charged by statute with two specific duties: (a) Supervision of the *current* business activities of the War Department; and (b) preparation of plans for mobilizing our economic resources for the national defense and the execution of those plans in an emergency.

These two functions, although related, are so different in character that the Assistant Secretary of War has considered it advisable up to the present time to keep them largely separated in his office. It is with the second of these duties that the Army Industrial College is primarily concerned.

In carrying out his responsibilities under the Act, the Assistant Secretary of War first established an Army Industrial Staff—or Planning Branch as it is called in his office—where the industrial phases of warfare could be studied and planned in much the same manner as military problems are studied and solved by the Army General Staff. To this Planning Branch—composed of selected officers from the supply branches of the Army—was delegated the task of outlining the problem of industrial mobilization in its broadest aspects, determining the phases of the problem which would require most attention in war, finding reasonable solutions for those difficulties and establishing policies which the supply branches should follow in working out their plans—in brief, of assuring adequate provision for the mobilization of the national material resources for war.

The task was tremendous, involving every phase of our economic life. It soon became apparent that the officer personnel of the Army must be made familiar at least with the main features of the problem more rapidly and on broader lines than would be the case if they were assigned to some detailed phase of the work either in the office of the Assistant Secretary of War or the supply branches. Out of this need grew the Army Industrial College, established by General Orders No. 7, War Department, February 25, 1924, largely as a result of the vision of the then Director of Procurement, Col. Harley B. Ferguson,

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C. E., and the hearty support of his chief, the then Assistant Secretary of War, Dwight F. Davis.

It is interesting to note that the recognition of the importance of industry in war evidenced by the establishment of the office of the Assistant Secretary of War, the Planning Branch and the Army Industrial College parallels the recognition by the great educational institutions of the country of the importance of business in our economic life, as shown by the recent rapid growth of schools of business administration. The World War brought home to the Army the fact that the economics of war had been neglected. The business catastrophe of 1920-21 indicated to our colleges a vital need in our educational system. The Army and the country at large have adopted a common method—education—in assuring that these bitter experiences shall not be repeated.

THE order establishing the college reads as follows:

"1. A college, to be known as the Army Industrial College, is hereby established for the purpose of training Army officers in the useful knowledge pertaining to the supervision of procurement of all military supplies in time of war and to the assurance of adequate provision for the mobilization of matériel and industrial organizations essential to war-time needs. 2. For the present such parts of the Munitions Building, located in Washington, D. C., as may be available and necessary will be assigned to its use. 3. Direct supervision and control of the Army Industrial College are vested in the Assistant Secretary of War."

It appears from this order that the purpose of the college is the training of officers in (a) planning for the mobilization of our material resources for war; and (b) supervision of the execution of these plans in a national emergency.

From the similarity in wording between the order establishing the college and that of the National Defense Act assigning duties to the Assistant Secretary of War, it might be assumed that the real purpose of the college is to train officers for duty in the office of the Assistant Secretary of War. While this thought may have been prominent when the institution was first set up, it is apparent that the development of the college has taken place along lines that make the institution essential not only to the Assistant Secretary of War but to the supply branches as well. The gradual broadening of the curriculum to include a study of supply branch and procurement district activities in procurement planning and the cordial support given the institution by the chiefs of the supply branches, to whom most of the graduates return for assignment to duty, are indications pointing to the position which the college is expected to occupy.

The Secretary of War, Mr. Davis, has expressed himself on the purpose of the college in the following words:

"* * * The Army Industrial College has an important part to play in connection with the industrial side of the War Department in time of war. Just as our service schools are developing officers for General Staff and tactical command, so this school was created by the Secretary of War for the purpose of instructing officers of the procurement branches in the higher duties of their profession in connection with procurement of supplies in time of war.

"* * * Let me urge you to take advantage of every opportunity of studying the methods used by industrial establishments in planning programs and executing them while retaining control of the same at every stage of progress."

Maj. Gen. C. C. Williams, Chief of Ordnance, U. S. Army, whose hearty support of the college has helped it over many obstacles during its period of development, has expressed himself on the subject as follows:

"My conception of the Army Industrial College is that it is an institution whose primary purpose is to keep alive the realization that there is a problem in war procurement and to train officers how best to direct industry to war production. I do not expect the college to train officers for duty at the manufacturing arsenals of the Ordnance Department—that will be taken care of within the department—but I do expect Ordnance officers graduating from the institution to have a better and broader grasp of their duties on procurement planning, whether in my office or in the procurement districts, than they could obtain elsewhere."

These authoritative statements indicate in a broad way the purpose of this institution. The remainder of this article will attempt to show the methods adopted and progress made in accomplishing this purpose.

IN the early days of the college the subject of industrial mobilization for war was little understood. No set curriculum could be established and but few students were assigned to take the course. Their duties consisted chiefly in analyzing the problem into its components, determining the factors which might become critical in mobilizing our economic resources for war and suggesting the lines along which planning activities might be directed most profitably. The solution to the problem was not sought at that time—the real difficulty was in visualizing the problem itself in its broadest aspects. During this period of orientation in the college, the Planning Branch, and the supply branches were also formulating principles along the same lines—all coördinated with doctrines developed in the General Staff and the War College for the mobilization of the man power of the Nation. As the problem became clearer through this study, the curriculum of the College became more definite, the course was expanded to include the new subjects developed and the number of students and the length of the term were increased.

Beginning with the school year 1926-1927, the length of the course was fixed at a full academic year—the previous terms having been of five months duration each. The number of students authorized has now been set at 40 from the supply branches of the Army, plus such officers as may be detailed from the Navy, the Marine Corps, the Finance Department and the line of the Army. In the present session 40 officers are attending—including one Navy officer, one Marine Corps, one Judge Advocate, one Finance, one Cavalry and one Coast Artillery officer—the remaining 34 being detailed from the supply branches.

The student personnel is selected by the bureau chiefs from their officers having an efficiency rating of above average or better, without restriction as to rank. At present the quotas set for the various branches are as follows: Quartermaster Corps nine; Ordnance Department nine; Air Corps six; other supply branches, four each. Assignment to duty at the college is made usually at the beginning or at the end of a tour of duty in Washington since this avoids unnecessary change of station.

The faculty of the college is composed of the Director, Col. William P. Wooten, C. E., the Assistant Director, Col. Irving J. Carr, Sig. C., an executive officer and seven instructors. Most of the instructors, in addition to their duties in the college, are active members of the Planning Branch, Office of the Assistant Secretary of War, and this assures the coördination of the work of the two institutions which is so necessary to the success of both.

ALTHOUGH the curriculum of the college has not yet become completely stabilized, the methods of instruction are quite well crystalized and, while independently developed, follow closely those of our best post-graduate schools. The faculty endeavors to impress upon the students from the beginning of the course that few, if any, final solutions have been reached on the various problems given in the course and encourages these officers to criticize fully any of the ideas presented and to discuss their conclusions with other students, members of the Planning Branch, the faculty and officers of their own corps. A comprehensive series of lectures by experts on various phases of the problems is provided so that the students may obtain contact with these men and secure the advantage of a broad viewpoint. These lecturers include officers of the Planning Branch, the supply branches, and the General Staff as well as experts from other Government departments and industrial leaders whose experience is particularly applicable. Contacts maintained with various economic agencies and with the Harvard School of Business Administration are also serviceable in obtaining authoritative information on the various subjects studied. The contact with the Department of Commerce, particularly with the Bureau of the Census, the Bureau of Foreign and Domestic Commerce and the Bureau of Standards, and with the Department of Labor is particularly helpful in making available to the students much material needed for their work which is not obtainable in published form.

An essential factor in the instruction of the student officers of the college is the library of the Planning Branch. This library contains the voluminous records of the War Industries Board and, through the coöperation of the supply branches, the Planning Branch and the college itself, is rapidly being expanded to include the more important publications, both domestic and foreign, that have a bearing on industrial mobilization. In recognition of the fact that the studies in the college pertain largely to industrial subjects, it is the aim to make this library as complete as possible in publications relating to business activity and a considerable number of the best books on this subject have already been collected. Any deficiencies in this library are met at present by borrowing from the Library of Congress, the War College, the supply branches and the numerous other sources available in Washington.

The work done in the college consists almost entirely in the preparation of solutions to assigned problems. These problems require either individual or committee study and written reports. From one to three weeks are allowed for the solutions, depending on the complexity of the problem. The general subject is first outlined to the student, with certain broad requirements given to indicate the desired scope of the investigation and a few references to guide him to the literature on the subject. He is then allowed the greatest latitude as to the extent to which his research may be carried and is encouraged to do his own reasoning from the facts developed. The solutions to the problems are presented to the class as a whole, where discussion is encouraged to clarify the subject and permit definite conclusions to be reached. The reports are also studied by the instructors and any constructive criticism thought desirable is given to the students for their information. The fact that these reports are given careful consideration in the Planning Branch and written criticism furnished the college also aids materially in securing coördination between the two institutions and provides valuable suggestions to the Planning Branch itself.

The aim of the college is, above all, to obtain *practical* solutions. In the study of the problems, students are urged to develop the facts as they exist today and reach conclusions based on these facts rather than attempt to visualize conditions which may or may not be found in some far distant emergency. By the process of repeating the studies from year to year the solutions are then kept abreast of developments and yet remain in an immediately available and practical form.

As has been stated, the methods of instruction and the content of the course at the college are still in the process of development. The students themselves are asked at the close of the school year to comment on the course and make any recommendations they desire on the methods of conducting the institution and the subjects included in the curriculum. These comments are carefully considered by the faculty and have resulted in considerable improvement in the college. The Advisory Board of the college, composed of the chiefs of the supply branches of the Army, reviews the report of the faculty and makes recommendations which have been very helpful in increasing the value of the institution as a part of the Army educational system. Liaison with the Harvard School of Business Administration, maintained by contact with the faculty of that institution, and the inclusion of its officer graduates among the instructors and student body of the college have also aided in improving the methods in use.

THE July-August, 1927, issue of ARMY ORDNANCE (Vol. VIII, No. 43), described the course of the Army Industrial College as it was arranged at that time and gave a brief outline of the content of each of the problems assigned for solution. The course of the school year 1928-1929 is practically the same, with some slight rearrangement in the order of the work and the addition of a few new problems. It will be unnecessary to repeat this outline of the course here, but an analysis of its contents may throw some additional light on the general purpose of the college and the scope of the curriculum.

During the first week of the school term the student officers of each supply branch devote their time to an organized study of the activities of their own branches in procurement planning, under the direction of the several branch-planning officers. This orientation study serves to acquaint the students with the branch officers with whom they will come in contact during the course and tends to place in true perspective the importance of the supply branches in the general scheme of war procurement. This study tends to emphasize the fact, which is further brought out during the progress of the course, that the Assistant Secretary of War is a supervising and coördinating agency

only and that the supply branches are the operating agencies.

After a brief period devoted to the analysis of problems and the writing of reports, the next subject considered in the college is outlining the general problem of war procurement. In this study the students review the industrial history of the World War period and determine the principal difficulties experienced in regard to procurement of military supplies during that time, the causes of the difficulties and the steps taken to overcome them. The fact is emphasized, however, that another national emergency will undoubtedly bring forth different industrial conditions than prevailed during the World War and the students are cautioned against placing too much dependence on historical precedent in drawing conclusions. This study, however, does aid in visualizing the problem of war procurement and goes far in analyzing it into the factors which are likely to cause trouble—which factors are to be studied in detail later in the course.

The general problem thus having been developed and broken down into its more important subdivisions, the next subject taken up is that of the organization necessary for its solution. Here the students first take up the principles of organization and management found successful by large corporations in the commercial world and then study the organization set up in the War Department for procurement planning and war procurement. This study tends to develop any possible source of weakness in the War Department organization and focuses attention on those principles of operation which successful business concerns have found to be necessary. The study of the War Department organization includes an investigation of the functions and interrelationship of each of the important agencies in the chain of war procurement and brings out the part which each plays in preparing the complete plan for assuring the supply of munitions in war. It is, therefore, a valuable orientation problem.

At this point in the course there is introduced a five-week review of certain fundamentals of business procedure based on the curriculum of the Harvard School of Business Administration. This study is conducted by Maj. H. K. Rutherford, Ord. Dept., U. S. A., an instructor-graduate of that institution. Since procurement planning and war procurement are essentially business probems, it was felt that an introduction to the language, the problems and the methods of successful business should be given early in the course. Instruction in this subject is given by means of assigned readings in the best available texts on the various topics, followed by conferences in which essential points are discussed. It is impossible in such a short period, of course, to do more than outline some of the more important situations which business men are called upon to meet and to point out some of the methods employed. The study, however, does introduce the student to the literature on the subjects covered and aids in guiding him in any later investigation he may desire to carry on along this line.

At this point in the course, a short problem on current procurement of the War Department is introduced for purposes of orientation in the current activities of the office of the Assistant Secretary of War and the supply branches.

The course up to this time has consisted almost entirely of orientation problems designed to give the officers the necessary background with which to proceed with the study of details. The remainder of the term is devoted to the investigation of the subordinate problems which the previous analysis has developed, an attempt to find workable solutions to these problems and building these solutions into a complete, workable plan of war procurement.

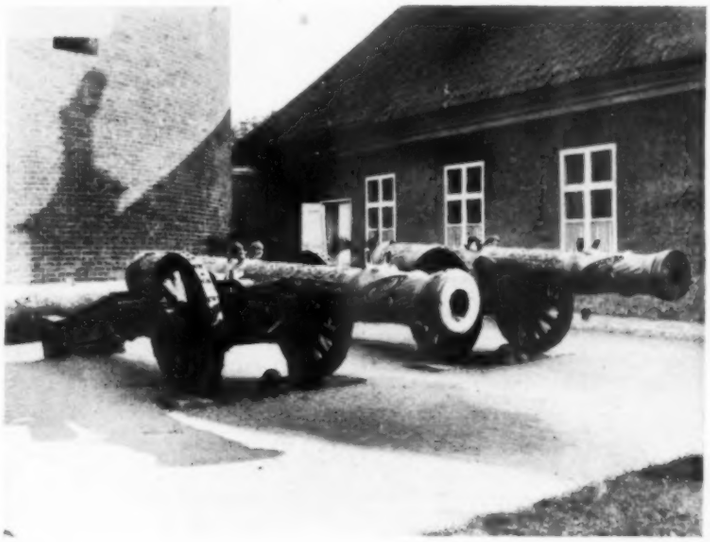
THE fact that the Army Industrial College, with the War College and the Command and General Staff School, ranks as a general service school, indicates in a broad way the future scope of its activities. Although as yet in its infancy, it has grown rapidly in influence from year to year as indicated by the increasing number of students, the inclusion of line officers in the student body and the hearty approval expressed by the many industrial leaders who have become acquainted with its activities. The assignment of Navy and Marine Corps officers to each course has been of material assistance in obtaining that understanding betwen the Army and Navy which is so essential to a common effort in the national defense.

It does not seem probable that the college will ever develop into an Army school of business. Its task of training officers for their proper work in procurement planning is so great that it does not appear either practicable or desirable that the course at the college should take the place of the instruction which certain officers of the supply branches are now receiving from such institutions as the Harvard School of Business Administration, the Babson School and others. It seems desirable, rather, that officers attending these civilian institutions should be graduates of the Army Industrial College who have shown special aptitude for further training along business lines. Their study in the college will then have indicated to them the phases of business activity which are particularly applicable to the War Department procurement problem and the courses at the civilian schools will permit them to study those subjects which give promise of being most useful to the service. At the present time, no policy in this regard has been fixed. The Industrial College, however, through the coöperation of the faculty of the Harvard School of Business Administration is aiding in making the latter institution of greater usefulness to the Army by supplying it with problems which Army students at that institution can use as thesis subjects.

The work of the Army Industrial College will never be finished. As long as industry continues to develop improved methods of handling large scale operations, so long will it be necessary for the Army to weave those improvements into workable plans for the utilization of industry in the National Defense. As the Secretary of War, Mr. Davis, has expressed it: "Procurement is best accomplished when there is applied to its solution certain sound and basic principles which the industrial activities of the world have developed."

The Army Industrial College appears to be an essential means to this end, aiding, as it does, in disseminating within the Army those principles of industrial preparedness which Army Ordnance pioneered and has so well continued to spread among our industrial leaders. The future holds for the college the promise of an ever-increasing influence and a continuing responsibility that an understanding of the economic aspects of war shall not be lost to those whose duty it is to plan the national defense.

Ordnance Abroad



Gustavus Adolphus Cannons.

These veterans of Sweeden's monarch were used in his campaigns against Denmark, Russia, Poland, and Germany. They are now on exhibition in Gripshohn Palace, Sweden.

Sharpshooting with Boots and Without.

Expert Russian marksmen shown taking part in the recent All-Union Spartakiada, near Moscow.

Modern Armament in Old Moscow.

Part of the procession of tractors of the Russian Army during a military review recently staged in Moscow in honor of the visit of the Padishah of Afghanistan, Ammanula Khan.

Stainless Steel In Small Arms

By Herbert O'Leary*

INASMUCH as the subject matter of this paper concerns the use of stainless steel in the manufacture of small arms it may not be inappropriate to begin by offering a few general comments concerning the material itself apart from a consideration of any use to which it may be put.

In the first place it is to be noted that the term "stainless" when applied to steel is relative only. There is no known steel which is absolutely stainless or rustless. However, the type of steel known as stainless is one which is resistant to rust and other ordinary forms of corrosion when subjected to the action of agents which normally cause corrosion in the case of other types of steel. Not all stainless steels are resistant to corrosion to the same degree and we thus find that, depending upon chemical composition, the heat treatment to which subjected, and the condition relative to polish, etc., one steel may be highly resistant to rusting as well as to a great many other forms of corrosion whereas another steel, also classified as stainless, offers little more resistance than ordinary carbon steel.

In the trade there are two materials, both steel, to which the quality of rustlessness under ordinary conditions is ascribed. One of these materials is known as stainless steel and the other as stainless iron; the main difference between the two being the amount of carbon present. If the material contains more than 0.12 per cent carbon it is classified as stainless steel whereas if the carbon content is less than 0.12 per cent it is classified as stainless iron. This classification is purely arbitrary but it has been adopted by common consent and is generally adhered to.

The element whose presence confers the quality of stainlessness upon stainless steel and stainless iron is chromium. The amount of chromium present varies widely but it is seldom that less than 10 per cent or more than 20 per cent is found in either stainless steel or stainless iron. The more common varieties of stainless steel contain about 0.30 per cent carbon and from 9 to 16 per cent chromium, but in the best grades chromium is restricted to from 12 to 14 per cent. The commercial grades of stainless iron contain approximately 0.10 per cent carbon with chromium about as found in stainless steel. In both materials other elements are present about as found in carbon tool steels.

Of the two materials, stainless steel was developed and put to commercial use before stainless iron, although neither was used to any extent prior to about 1913. Stainless steel is stainless or rustless only when hardened and polished. It is hard and dense and difficult to forge, stamp, press and machine but its resistance to corrosion when properly heat treated and finished is of the highest order. It found its first and most general use in the manufacture of cutlery, undoubtedly because the shapes are simple and the principal manufacturing processes are grinding operations.

Due to the difficulty of working stainless steel and to the fact that it is rust resisting in the heat-treated condition only, its field of usefulness is quite restricted. Efforts to overcome the limitations of stainless steel resulted in the development of stainless iron. The latter, although not as resistant to corrosion as stainless steel, can be machined and otherwise worked much more readily and has the further advantages of not requiring heat treatment to develop its rust-resisting qualities. It should be noted, however, that heat treating will improve both its resistance to corrosion and its physical properties.

Because of the rust-resisting qualities of stainless steel and stainless iron it seemed that one or both might be used to advantage in the manufacture of those parts for small arms which experience has indicated frequently become unserviceable due to corrosion.

IN small arms of all types the part which requires replacement most often, due to unserviceability, is the barrel. Therefore it seemed that if barrels could be made of stainless steel a real economy would result. Work has accordingly been concentrated mainly upon this component with the idea in mind that the investigation would be extended to include other parts in case results obtained with barrels seemed to justify so doing.

The problem naturally divided itself into three parts, i. e., determination whether the steel could be manufactured into barrels successfully, determination of the rust-resisting qualities of the steel used, and determination as to whether the completed barrels would meet service requirements as to accuracy and accuracy life.

In an endeavor to obtain the best material in respect of corrosion resistance and machineability all of the principal manufacturers of stainless steel were consulted. They coöperated by furnishing numerous samples which were subjected to chemical, physical, machineability and corrosion tests. Also they furnished the results of their own experience as well as that of others in regard to machining methods and heat-treating problems. In all some 70 or 80 samples of stainless steel and stainless iron have been considered and the machineability and rust-resisting qualities of 50 or 60 of these samples have been tested. The rustlessness of many of the samples was very good but in all cases the machining was found to be difficult and many samples otherwise satisfactory were totally unsatisfactory in this respect.

The machine operations which give the most trouble in the manufacture of a barrel are the drilling, reaming and rifling operations. Stainless steel proper, although its resistance to corrosion and its physical characteristics seemed to make it an ideal substance for barrels, had to be eliminated from consideration because it was impossible successfully to perform these operations and the simplest operations, such as turning, could be performed only at great cost and even then not altogether satisfactorily. Even stainless iron, for which it is claimed that it is nearly as machineable as the more common grades of alloy steels, gave a great deal of trouble in the drilling, reaming and rifling operations. However, although difficult, these operations can be performed successfully on stainless iron and

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Specimens of Stainless Iron.

Specimens of Carbon Barrel Steel.

Two ordinary primers were exploded against each of these specimens and all were then subjected to laboratory test for corrosion for approximately one week. It will be noted that each specimen of carbon barrel steel rusted badly over its entire surface and that the rusting was more pronounced where the surface had been affected by the primer fouling. In the case of the stainless iron it will be noted that pronounced rusting took place only on that portion of the surface affected by the fouling. The other portion of the surface rusted slightly but not sufficiently to be shown in the photographs.

the problem resolved itself into finding a grade which could be machined without unduly increasing the cost of the completed barrel and which at the same time would offer sufficient resistance to rusting to make it appear attractive. After many trials it appeared that a stainless iron containing approximately 0.09 to 0.11 per cent carbon and 11.0 to 14.0 per cent chromium, with other constituents about as found in a good grade of carbon steel, would meet these requirements in a fairly satisfactory manner.

As just noted the operations which give the greatest trouble are drilling, reaming and rifling and, of course, the longer the barrel and the smaller its caliber the more troublesome these operations become. Accordingly it seemed advisable to devote the greatest effort to the making of barrels for the caliber .45 automatic pistol because it is evident that if such barrels could not be made to advantage there would be little point in carrying the investigation further.

Nevertheless, in spite of the large caliber of the pistol barrel and its short length a great amount of time and energy was consumed before a method of drilling was discovered which gave fairly satisfactory results. The manufacturer of the stainless iron which was being used recommended quenching in oil from 1800° F. followed by a draw at about 1050° F. This left the stock with the required physical characteristics and at the same time was supposed to leave it in a readily machineable condition. In drilling, however, the stock seemed tough and was picked up by the drill point and caused endless trouble. Also only one double blank could be drilled without regrinding the drill whereas in the case of standard steel six to eight double blanks can be drilled before a regrind is necessary. These troubles were finally reduced to a workable basis by annealing the blanks and then rough turning and machining up to the drilling operation. The blanks were then hardened and given a slight draw after which they were drilled, reamed and rifled. In other words, these operations could be performed satisfactorily only when the stock was in the hardened condition. After rifling the blanks were given the final draw at about 1100° F. to obtain the required physical qualities after which the final machine operations could be performed without undue difficulty. It will be noted that this procedure is contrary to that usually followed in the manufacture of barrels in which the blanks are given the final heat treatment after forging and before any machine operations at all are undertaken. It has been found that

this unusual procedure is satisfactory in the case of pistol barrels but in the case of the longer machine gun and rifle barrels probably it would be unsatisfactory because of warping and twisting caused by the final draw.

THE procedure just described was developed in connection with the manufacture of about 200 barrels and the manufacture of the second hundred seemed so successful that Springfield Armory felt that it was in a position to start manufacture in quantity. An order for 2,000 barrels accordingly was placed and was successfully completed some months ago. As a result of the experience gained on this order, Springfield Armory now feels that it can undertake the quantity manufacture of stainless iron pistol barrels at any time with assurance that such manufacture can be carried on as successfully as the manufacture of barrels of standard steel.

The unit cost of these 2,000 barrels was about 60 per cent greater than the unit cost of standard steel barrels; the costs in these two cases being $2.31 and $1.47, respectively; that is, the stainless iron barrel costs 84 cents more than the standard steel barrel. This increase in the cost of the stainless iron barrel over that of the standard barrel is a fairly accurate indication of the difference in the machineability of the two types of steel. Although accurate figures are not at hand it is roughly estimated that approximately 20 per cent of the increase should be charged to cost of machining and 80 per cent to tool maintenance including tool replacement. With reference to tool replacement it is estimated that the tool wear is approximately twice as great in the case of stainless iron barrels as it is in the case of standard barrels. It is interesting to note in connection with the matter of costs that one of the commercial manufacturers of pistols investigated the possibility of using stainless iron for barrels and at the end of the investigation concluded that the increase in the tool cost would run from 300 to 400 per cent and the increase in machine labor cost about 80 per cent.

No experimental work in connection with the production in quantity of barrels for small arms other than the pistol has been undertaken at Springfield Armory. However, a few caliber .30 machine gun barrels were manufactured for test purposes and to obtain some information concerning the practicability of actually manufacturing such barrels. Also approximately 50 caliber .30, Model 1903, stainless iron barrels are now being manufactured for the same purpose. In addition to these machine gun and rifle barrels a few caliber .30 machine gun barrels and a few caliber .22 rifle barrels were obtained from a commercial sporting arms manufacturing company for test purposes. The experience with stainless steel in connection with the manufacture of caliber .30 machine gun and rifle barrels was about the same as in the case of pistol barrels but owing to the greater length of the barrels and their smaller caliber, operations which were found difficult in the case of the pistol barrel were found to be still more difficult in the case of the machine gun and rifle barrels.

FOR the determination of the rust-resisting qualities of the steel used in the manufacture of barrels, two methods of testing have been employed. One is a laboratory test in which polished samples of the steel are sprayed with a saturated salt solution once every 24 hours. Between applications of the salt solution the samples are subjected to ordinary atmospheric action, usually indoors at room temperature. The other test is a firing and corrosion test of the completed barrel. In this test a number of rounds of service ammunition are fired from the barrel and the barrel without cleaning of any sort is then subjected to the action of steam. For this purpose it is placed in a closed chamber and live steam is turned into the enclosure for a sufficient length of time so that when the vapor formed by the steam has entirely disappeared small drops of water can be seen on the exterior of the barrel. After the steam is turned off the barrel remains in the chamber until the vapor formed by the steam has disappeared entirely after which the barrel is removed and exposed to ordinary atmospheric action usually indoors. This treatment is repeated three times daily for two days with intervals of not less than three hours between successive treatments. After the sixth treatment the barrel is exposed to ordinary atmospheric action, usually indoors, for a period of not less than 16 hours after which the bore of the barrel is cleaned and examined thoroughly. This test is a very rigid one and it is believed that a steel which does not rust or pit when subjected thereto will be proof against corrosion under service conditions.

In the salt spray test all of the samples of stainless iron made into barrels showed great superiority over standard carbon steel in respect to rust-resistance and pitting. Whereas the carbon steel showed severe pitting at the end of 24 hours, stainless iron showed no pitting at the end of this period of time and only very slight pitting at the end of 48 hours. In the firing and corrosion test of completed barrels, however, the superiority of stainless iron was not so marked although it still showed an appreciable superiority. Rusting and pitting started after the second or third application of steam and continued to increase rapidly from then until the end of the test, while carbon steel barrels subjected to the same treatment started to rust immediately after the first application of steam.

THE results of these and of other tests, such as the explosion of service primers against polished specimens of steel, indicate that, although stainless iron is appreciably more resistant to corrosion under ordinary circumstances than is standard barrel steel, its resistance is lowered to a great extent when barrels made thereof are fired and the products of combustion of the powder and primer charges are not removed from the bore. In this connection it is known that the resistance of both stainless steel and stainless iron to corrosion varies directly with the degree of polish of the surface. The bores of well made rifle and pistol barrels have a reasonably high degree of polish and it would therefore seem that they should resist rusting to a greater extent than the results of the firing and corrosion tests heretofore described indicate to be the case. In explanation of this apparent lack of consistent results it is to be noted that when a cartridge is fired in a barrel the gases formed by the burning of the primer and powder charges develop a high pressure and the products of combustion are deposited on the surface of the bore under the action of this pressure and accordingly make more intimate contact with the polished surface of the metal than would be the case if they were merely sprayed on, as is done in the salt spray test. The products of combustion of the primer and powder charges of most present day service cartridges

are highly corrosive under normal atmospheric conditions and when these products make very intimate contact with the metal it appears that the protection ordinarily afforded by the polish of the bore must be decreased. No data are at hand to support this explanation and it is offered merely for what it may be worth.

The conclusion to be drawn from the observed behavior of stainless steel in the presence of the products of combustion of the primer and powder charges deposited on the bore by firing is that stainless steel barrels should be cleaned thoroughly after firing if the full benefit of the rustless nature and character of the metal is to be realized.

TO determine the effectiveness of stainless steel and stainless iron in withstanding erosion caused by firing, a test was conducted with caliber .30 machine gun barrels. In this test the following were used:

3 barrels made of stainless iron supplied by different steel manufacturers;
2 barrels made of stainless steel containing 0.515 per cent carbon, 8.47 per cent chromium and 1.63 per cent silicon;
1 barrel made of a particular kind of bronze;
1 barrel made of tungsten steel;
3 standard barrels whose bores had been chromium plated by Frankford Arsenal, and,
1 standard barrel taken from the regular supply stock.

1, A Standard Carbon Steel Machine Gun Barrel; 2, 3, and 4, Stainless Iron Machine Gun Barrels; and 5, Barrel Made of Bronze, all of which were Fired for Erosion. Details of Results are Explained in the Text.

The barrels were first proof-fired and then fired in bursts of 2,000 rounds each up to and including 6,000 rounds after which the size of the bursts was reduced to 1,000 rounds. At the beginning and after each burst each barrel was targeted and star-gaged. The firing of each barrel was continued until clear indications of keyholing were obtained in the target firing or until the barrel became otherwise unserviceable.

As expected the bronze barrel became unserviceable almost at once although to everyone's surprise it successfully withstood the firing of three high pressure test cartridges at the beginning of the test. Upon examining the barrel at the conclusion of the firing of the first 2,000-round burst it was found that the lands had been entirely worn out throughout the entire length of the bore and a deep furrow had been cut or burned in one side of the bore for a distance of 4 inches in front of the bullet seat. It is remarkable that the barrel did not fail before the firing of the burst had been completed.

Of the three stainless iron barrels one was declared unserviceable after 10,000 rounds had been fired and the other two after 9,000 rounds each. The first "sil-chrome" barrel was declared "out" after 11,600 rounds and the standard stock barrel after 10,000 rounds. The behavior of the "sil-chrome" barrel which remained in the test for 11,600 rounds seemed so promising that a second barrel of the same kind was entered but this one went out after only 4,000 rounds, although a total of 9,000 rounds was fired. From a consideration of these results it will be noted that there is every indication stainless steel does not seem to be any more resistant to erosion than standard barrel steel.

With reference to the other barrels fired in this test the tungsten steel barrel was declared unserviceable at the conclusion of the firing of 6,600 rounds due to the formation of a ring or bulge about 2¼ inches from the muzzle and just in front of the muzzle gland. The formation of a bulge of this kind is not uncommon and so far as known cannot be charged to the steel. Judging from the star-gage records of all the barrels fired in the test this tungsten steel barrel withstood erosion somewhat better than any of the others with the exception of the chromium-plated barrels. The steel of which it was made contained about 2.85 per cent tungsten but its other ingredients and the percentages present are unknown.

The three standard steel barrels the bores of which had been chromium plated by Frankford Arsenal gave the best performance of all. Each one was fired a total of 20,000 rounds and at the conclusion of this firing, judging by the size of the targets and the star-gage records, they were still entirely serviceable. The performance of these barrels is the most remarkable ever coming to the attention of Springfield Armory in connection with the endurance testing of machine gun barrels. Not only was there very little increase in the size of the targets but practically all of the wear or erosion was confined to the first two inches of the bore directly in front of the bullet seat, and after firing 20,000 rounds the wear in this section was little or no worse than is usually due to the firing of 8,000 to 10,000 rounds through a standard barrel.

I should now like to conclude by expanding somewhat on my own personal views as to the present usefulness of stainless steel in the manufacture of small arms. I think it

may be concluded from the investigation conducted at Springfield Armory:

a. That stainless steel of the type which can be successfully manufactured into parts for small arms is more resistant to rusting than types of steel at present used.

b. That due to the greater resistance of stainless steel to rusting its use in the manufacture of parts which have to be replaced frequently due to unserviceability caused by corrosion would reduce the number of such parts replaced each year.

c. That stainless steel of the type which can be successfully manufactured into parts for small arms is no more resistant to erosion than types of steel at present used.

d. That a stainless steel part will cost at least 50 per cent more to manufacture than the same part made of present standard steel.

The statement has already been made that in small arms the part which requires replacement most often due to unserviceability is the barrel. The small arms in which we are most interested in this connection include the caliber .50 machine gun, the caliber .30 rifle, automatic rifle, and machine gun, the caliber .22 rifle and the caliber .45 automatic pistol. Practically all of the barrels pertaining to these weapons which have to be replaced because of unserviceability become unserviceable due to either corrosion or erosion of the bores or to a combination of the two. Corrosion of the bore is the result of chemical action which occurs when the bore has been insufficiently or improperly cared for. As already stated the products of combustion of the primer and powder charges of most of our present service cartridges are highly corrosive and the corrosion of the bore, therefore, is usually accelerated greatly after firing if these products of combustion are not promptly removed. Erosion of the bore is due to the mechanical action of the primer and powder gases and of the bullet in passing through the bore.

If consideration now be given to the causes for the unserviceability of the barrels pertaining to the weapons just mentioned it will be noted that in some cases it is erosion which gives the most concern while in other cases it is corrosion.

The erosion of caliber .50 machine gun barrels is particularly severe and is giving the Ordnance Department considerable trouble at the present time whereas corrosion is comparatively unimportant. All caliber .30 weapons are fired a great deal and erosion is therefore an important factor in caliber .30 barrels. Corrosion is also important in reference to these barrels because many become unserviceable and the accuracy of many others is impaired every year due to pitting, rusting, etc. However, as between the two, erosion seems to be the more serious.

On the other hand, the matter of the corrosion of caliber .22 rifle barrels is of paramount importance and the matter of erosion of little importance. The reason for this is that caliber .22 ammunition is not particularly erosive but it is difficult properly to care for the bore of the barrel because of its small size. In the case of the caliber .45 pistol barrel unserviceability due to erosion alone is almost unheard of but at the same time the annual replacement is comparatively high and many of the replacements must be due to unserviceability caused by corrosion, so the matter of corrosion accordingly assumes importance.

From what has just been said it follows that in the case of caliber .50 machine gun barrels and caliber .30 rifle, automatic rifle and machine gun barrels, erosion is of more immediate concern to the Ordnance Department than corrosion but that in the case of caliber .22 rifle barrels and caliber .45 automatic pistol barrels corrosion is of greater concern.

Tests heretofore described have shown that stainless steel when made into barrels is as erosive as present standard barrel steels, and, therefore, it does not appear to be a very attractive material for the barrels referred to above in which avoidance of erosion is of great importance and the avoidance of corrosion of comparative unimportance. Naturally in such barrels the reduction of the tendency to corrode is of value but the advantage gained by using stainless steel for the purpose would be more than off-set by the increase in cost of the barrels and the reduction in production. We, therefore, should look for some means other than stainless steel to increase the life of these barrels.

In connection with caliber .22 rifle and caliber .45 automatic pistol barrels in which corrosion is the cause for deterioration it would appear that stainless steel could be used to very good advantage. However, until it becomes possible to work stainless steel with greater facility than at present, it cannot be used economically for caliber .22 rifle barrels because the length and small caliber of this barrel make it too difficult to manufacture. On the other hand, in the case of the pistol barrel, it has already been demonstrated that the cost of manufacture is not unreasonably high and that such barrels can be made in quantity without too much difficulty. It is believed that the increase in cost balanced against the longer life due to a reduction of corrosion would be economical. Therefore, it is concluded that at present stainless steel can be used to advantage in the manufacture of caliber .45 automatic pistol barrels.

Machine Gun and Crew Landed from Airplane by Parachute

A MACHINE gun crew dropping down from the sky, picking up a machine gun, also dropped to earth, and then going into action, is a new angle of warfare made possible through the combined use of the airplane and parachute, and which was demonstrated before Maj. Gen. Charles P. Summerall, Chief of Staff, during his recent visit of inspection at the Air Corps Primary Flying School at Brooks Field, San Antonio, Texas.

While General Summerall and the officers accompanying him were inspecting the field, a bombing plane was hovering overhead. Shortly thereafter six men were seen to leave the plane and descend to the ground with parachutes. A few seconds later another parachute issued forth from the bomber and a machine gun floated earthward. The crew of six men secured the gun as it reached the ground, had it set up and firing within the space of three minutes.

This maneuver was staged for the purpose of demonstrating one of the many elements of surprise made possible by the airplane and the feasibility of landing ground troops with necessary equipment quickly from airplanes.

The Sword—From Combat to Ceremony

By Church M. Matthews*

THE founder of the first ordnance association probably was the aboriginal genius who conceived and manufactured the flint sword. He is by no means in undisputed possession of that honor, however, for the wooden swords of the American Indians or the Meri of the New Zealand natives may have antedated the sword of flint. Nevertheless, this fact is almost certain: the sword was not a development of the spearhead, dagger, or similar thrusting weapons, but was a separate and distinct utilitarian invention.

"Which are mightie and bigge to behould . . ."

Following the flint sword, fashioned like a thin segment of a circle, came the copper sword, and, later, the bronze one. Iron apparently was known before bronze was completely discarded, for examples of bronze and iron swords of the same ethnological period have been found side by side in archeological excavations. It appears that Ordnance Departments in those days also suffered from the lack of appropriations to replace antiquated weapons.

When at last steel was discovered, the already keen competition between sword and armor began with renewed vigor. As the sword increased in size, the area and thickness of armor multiplied. Eventually a condition of stalemate was reached when it became necessary to use both hands to lift the sword, and it required both courage and a squire to don one's armor. The state sword of Edward V of England, five feet eight inches in length, presents a good example of this two-handed type.

In the "True Art of Defense," Giacomo de Grassi of Modena, says of the two-handed swords: "Because one may with it, as a galleon among many gallies, resist many swordes or other weapons; therefore in the warres it is used to be placed neere into the Enseigne or Auncient for the defense thereof, because being of itself liable to contend with manie, it may the better safeguard the same. And because of its waight and bigness requires great strength, therefore those onlie are allotted to the handling thereof, which are mightie and bigge to behould, great and strong in bodie, and of stout and valiant courage." From which we may assume that Edward V used his sword's hilt as a seal more frequently than its edge as an argument, for data collected concerning the armor of the fifteenth and sixteenth centuries show that the average man of that time was smaller than he is today.

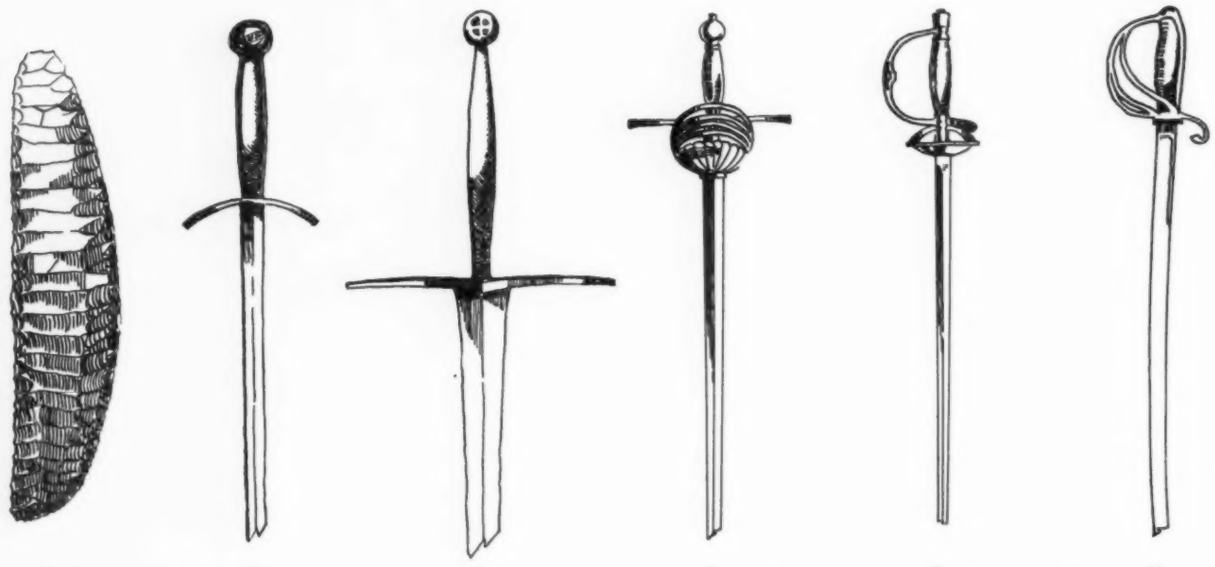
This period of inflation in the swordsmith industry occurred in the Medieval ages. Crustaceans were studied to gain ideas for improving armor joints, and no Italian monarch would have dreamed of giving a thé dansant without inviting his favorite swordsmith. Beauty as well as serviceability was demanded of his product, and such artists as Raphael, Michelangelo, Titian, Cellini, and Peter Vischer knit their brows to design military panoplies. Yet manufacturing on large scale production also existed—the armorers of Milan alone in the year 1427 were, within a few days, able to supply arms for 6,000 soldiers.

No general changes were made in the sword between the Roman invasion of England and the end of the fourteenth century. The Romans had learned the superiority of the point to the edge in the second Punic War, and the thrusting sword was still in general use.

In the fifteenth century a raised ridge ran along the longitudinal center of the blade. The weapons were still chiefly two-edged thrusting ones, and they had straight cross pieces for guards. This style of guard had been in vogue since 700 A. D. and served as a cross for the pious, if blood-thirsty, chivalry. During the Crusades the zealous knight could thrust his sword upright in the sand and perform his orisons before it. The origin of the modern saber salute dates back to the use of this guard, when it was the habit of the knight entering the lists to kiss the hilt and waft the kiss in the general direction of his lady. Today the reviewing officer is the unsuspecting target of these ghostly kisses.

In the early part of the sixteenth century the lesson the Romans had learned was forgotten and the two-handed cutting sword enjoyed much popularity. Eventually toward the close of the century, the superiority of the point was rediscovered and fencing as an art became established. In fact the French Parliament issued a proclamation, on the "20th day of August, in the year of our Lord 1554," to end the delinquencies of the University students who had forsaken the study of the ancient languages to study the more fascinating practice of the sword. Also, no doubt, their parents called upon the Almighty to witness the unsurpassed wildness of the younger generation. As a result

*This paper was awarded second prize in the annual prize essay contest, 1928, sponsored by the Army Ordnance Association for the best essay on an ordnance subject submitted by a member of the First Class, United States Military Academy. Illustrations by Cadet R. C. Wilson, U. S. M A., 1928.



1. Egyptian Predynastic Flint Sword. 2. Sword of Latter Part of Fourteenth Century. 3. State Sword of Edward V (1475-1483). 4. Italian Rapier of Seventeenth Century. 5. Small Sword of George I. 6. Cavalry Officer's Sword, 1880.

of the new interest in sword play, the guard had developed into the complete rapier hilt by the close of that century.

The seventeenth century brought as great a change of character as the sixteenth, both in art and implement. Cutting actions were discarded as brutal and less effective than the thrust, and the lengthy rapier had diminished to the dimensions of the small sword. The handle became even more complicated than that of the sixteenth century and had a profusion of guards, counterguards, and pas d'ane guards. The quality of the blades also began to deteriorate during the latter part of this century.

In the early part of the eighteenth century the two-edged sword was definitely discarded in favor of the three-edged bayonet-shaped French duelling sword. This, worn as a "walking" sword, has gradually been metamorphosed into the court sword of the present day, while the broadsword has remained the military weapon; consequently, from this period dates the absolute distinction between the court and the military sword, both finding their origin in the rapier. The present shape of the saber has come from the curved scimitar of the Orient via the light Hussars of Hungary. The curve was greatly modified in the middle of the nineteenth century although still in evidence in the sabers of our Mexican War.

WE have followed, rather sketchily it is true, the development of the sword by the materials used in its construction—wood, flint, copper, bronze, iron, and steel. The "modern history" of the sword may be further divided into four periods according to its shapes and styles. The first half of the sixteenth century belongs to the true sword, that unwieldy weapon of the artless knight. From the second half of the sixteenth century to the first quarter of the seventeenth century is the period of the lengthy, outlandish rapier. The third period may be called the transition period, covering the second and third quarters of the seventeenth century. The last is that of the small sword, beginning in the reign of Charles II and ending about the time of the French Revolution. Numerous types and varieties have been omitted for the sake of brevity, for each swordsman had his own ideas when selecting a weapon, or designing one. Yet narrow as the outline is, the gross inaccuracies of time and type of weapons, not to mention styles of fencing, that are depicted daily on the stage and in the cinema, should be easily detected.

Today the rifle has usurped the position of the sword as the soldier's "best friend" and remains "but a bastard of the kin; it is an article of commerce, supplied like skewers or chisels. . . ." The artist who was once the swordsmith has become the mechanic who is the gunsmith. The artist produced his sword with few special tools, entirely by hand work. His rough material was a bar of cast and hammered steel tapering from center to ends and which, cut in the center, produced two blades. Hammer and anvil did most of the work, and each swordsmith had his secret method of tempering.

Damascus steel has always enjoyed a greater fame than any other metal used in blades. The secret of its success rests upon the combination in it of two properties, toughness and hardness. To make steel sharp it must be hard, and to be hard, it must be cast steel. To make steel elastic, it must be tough, and toughness is given by sheer steel. These qualities are so incompatible and so hard to combine in a single piece of steel that nearly all makers abandoned attempts to attain them. European makers usually strove for the elastic blade while the Japanese War Department (established A. D. 645) required a sharp edge, so sharp that a blade held upright in a stream would cut into two parts the leaves wafted against it by the current. (*Cum grano salis!*)

The generic exterior appearance of damask steel was a surface figured with meandering lines like watermarks. The size of the lines and their pattern determined the quality of the blade. The blade itself was black, gray, or brown, and presented over all a varying sheen of blue, red or gold. The lines were an eighth of an inch wide in the high-class specimens, about as wide as a pencil mark in ones not so excellent, and if they were scarcely visible, the

blade was altogether contemptible. The pattern was as important as the size: as the lines curved, the merit rose. Straight parallel ribs indicated the lowest type; when twists appeared, the merit increased; when the marks were ruptured with dots between them, it became admirable; when the lines became a network of threads twisted in all directions, it became distinctly noble; and perfection was attained when those threads were in the pattern of chevrons or bunches of grapes spread evenly over the blade. The latter condition only needed a true golden gloss superadded to be acclaimed as a masterpiece of Damascus skill.

Those were only the outward characteristics and the inner nature was equally as exacting. It had to be sufficiently ductile and malleable that it could be hammered cold, yet when tempered it should become hard as granite and take an edge as sharp as the tooth of time. With all this, it should be supple as an eel so that no accident could break it.

These requirements were all met by an enthusiast of damask steel over fifty years ago. Colonel Anosoff, manager of an Imperial (Russian) factory at Zlatöust in the Urals, sought the inmost secrets of this art, and though he was not uniformly successful, he often produced examples that could not be distinguished from works of the old Syrian masters. Some of his swords could be bent until the point touched the hilt yet could cut through an iron bar. The Toledo blades can be packed in coils like watch springs; old Japanese blades have edges so sharp they can be used as razors; but never have the two qualities been joined in any other steel than damask.

Professor Dana found that blades of high price could be bought in either Constantinople or Cairo bazaars and which blades the truthful Oriental merchants guaranteed were of the finest ancient Damascus. But, in his words, "the peculiarity of this blade is that a slight rubbing with emery and oil removes all trace of the ancient markings, while on bending the blade, say to a right angle, it does not break but retains that somewhat inconvenient shape until straightended out by the use of the sole of the foot."

Next to Damascus, Spanish steel has probably been the most famous. The best metal was mined at Mondragon, in the Basque Provinces, and was said to have furnished most of the steel for Toledo blades, famous even in Roman times. In the ninth century under Sultan Abd-ur-Rahmen II their fame became even greater. Old writers ascribed the excellency of the Toledo blade to the properties of the Tagus water and sand. However, today the Tagus water is no longer used and water from a nearby well is found to be more convenient and equally efficacious. Other towns less famous than Toledo that were celebrated for their blades were Seville, Silongan, Madrid, Cordova, Catugel, Badajoz, and Valencia.

MODERN sword cutters could probably rival products like those of Andrea Ferrara but whence would come the demand? The old cutting and slashing type of cavalry attack is rapidly being superseded by a charge with raised pistols. Operations against Asiatic and African swordsmen in recent years by European troops have been the only occasions where a necessity was felt by individuals for a superior side arm and these individual demands were supplied in some cases by inserting old authentic blades into modern regulation hilts. The modern inferiority of blades is undoubtedly due to the modern indifference to such weapons. The use of the sword was discontinued entirely for a period in the first decade of the twentieth century by the British Army and now many wonder, no doubt, why it was ever reinstated.

The day of the sword is past and superior swordsmanship is a rarity found in a few men who practice sword-play as a sport—one which demands utmost nervous and muscular tension while it affords the refined pleasure of rhythmical action. It has been said that the history of the sword is the history of humanity and that the changes in the methods of fencing correspond roughly to changes in the manners of humanity.

The rough and brutal knight of the middle ages was fully as uncouth in his sword-play. He learned his principles—which may be described as those of the hacking-school—by standing in front of a six-foot post day after day for many a month, whacking, banging, and cutting at it.

After the Renaissance, armor was discarded in private life, men began to move about to a greater extent, and began to do that moving more and more on foot. Their ancestral swords were found too cumbersome and a lighter one was substituted, elegant as its predecessor had been sturdy, and vicious as its ancestor had been brutal. With this lighter sword (the rapier) came the true development of the art of fencing.

When the small sword superseded the rapier in the eighteenth century, a new style of fighting arose which consisted mainly in movements of the wrist. This was entirely within keeping with the manners of that age which appreciated the precise and polished style in literature of Addison, Pope, and Hume. When men fought duels in periwigs and ruffles, correct attitudes and movements were necessary.

But this sentiment has followed the fate of the fowling-piece. When nations go to war today they fight en masse with less thought of gentilesse or etiquette, and even the private vendettas of our own bootlegging rings are settled by the use of automatic weapons. The exponents of "cold steel" are properly in a minority, but the passing of this weapon cannot be viewed without a twinge of regret. The tales of Cellini, the exploits of D'Artagnan, the deeds of Ravanne and Dubois, still stir the blood of the reader.

"The sword performed a moral function and exercised a social action. It was not a mere swaggerer, a mere despot, or a mere killer; it forced men to respect each other, and since the downfall of the sword the notion and practise of deference and of manners between man and man have palpably diminished. While hectoring and violence have increased on the one hand, punctiliousness, courtesy, dignity, and fair name have still more ebbed away on the other; for the sword, with all its faults, was a gallant gentleman."

Today "that gift sent down from heaven which made Muleiber divine" is no longer the defender of life and honor. It remains merely as an official appendage in which the wearer takes very little interest. In the beginning it made man the lord of the universe, now it merely indicates the lord of the platoon. The "white arm," as the French call it, has become merely another item on an officer's expense account, another article to keep clean of rust. The weapon whose use was once a life study retains now only a few simple movements defined in regulation as the "Manual of the Sword," movements whose uses are confined to the parade ground. *Sic transit gloria mundi!*

Some of the Guests Grouped Around the Huge 16-inch Coast Defense Gun at the Tenth

Tenth Annual Meeting of the Army Ordnance Association

Extensive Program of Land and Air Armament Demonstrations and Technical Discussions Mark Occasion at Aberdeen Proving Ground. Over 10,000 Attend.

THE Tenth Annual Meeting of the Army Ordnance Association at the Aberdeen Proving Ground, Maryland, October 4, 1928, was, by and large, the most significant function of its kind in the history of American land armament. Attended by the Secretary of War and other members of the Cabinet, leaders of American industry and ranking officers of the Army, Navy and Marine Corps, the program of demonstrations was witnessed by more than 10,000 people. For the first time the attendance at these annual meetings was counted as visitors entered the reservation. The dials showed an attendance of 10,540 persons and 2,024 automobiles, with special trains from New England, New York, Pittsburgh and other points.

The program of demonstrations, featured by a spectacular Air Corps exhibition of tactical flying by bombing and pursuit planes from Langley Field, Va., and Selfridge Field, Mich., participation of units of the Experimental Mechanized Force and the firing and maneuver of new developments in Ordnance matériel, began promptly at 10 A. M. and continued without interruption until 7:30 P. M. The following branches of the Army participated in the various events: Ordnance Department, Air Corps, Quartermaster Corps, Field Artillery, Coast Artillery, Signal Corps, Corps of Engineers, Infantry and Chemical Warfare Service.

Among the distinguished guests were: Dwight F. Davis, Secretary of War; Chas. B. Robbins, the Assistant Secretary of War; F. Trubee Davison, Assistant Secretary of War for Aeronautics; Theodore T. Robinson, Assistant Secretary of Navy; Maj. Georges Scapini, Member, Chamber of Deputies of France; Wm. A. Starrett, O. W. Smith, F. S. Dickinson and L. H. Whiting, all of the War Department Business Council; John G. Sargent, Attorney General of the United States; William F. Whiting, Secretary of Commerce; Harry S. New, Postmaster General; Brig. Gen. Campbell King, Col. Stanley H. Ford, and Brig. Gen. Frank Parker, Assistant Chiefs of Staff; Maj. Gen. C. C. Williams, Chief of Ordnance; Brig. Gen. C. L'H. Ruggles, and Brig. Gen. Samuel Hof, Assistants to the Chief of Ordnance; Hon. Benedict Crowell, President, Army Ordnance Association; Wm. W. Coleman and Wm. C. Spruance, Vice-Presidents, Army Ordnance Association; James L. Walsh, C. L. Harrison, Pliny E. Holt, John C. Jones, Chas. H. Tenney, and R. M. Dravo, Directors of the Army Ordnance Association; Brig. Gen. F. H. Pope, Assistant to the Quartermaster General, U. S. A.; Maj. Gen. M. W. Ireland, The Surgeon General; Col. E. P. Easterbrook, Chief of Chaplains; Maj. Gen. Herbert B. Crosby, Chief of Cavalry; Maj. Gen. Fred T. Austin, Chief of Field Artillery; Maj. Gen. Andrew Hero, Chief of Coast Artillery; Brig. Gen. B. D. Foulois, Assistant Chief of Air Corps; Adm. Luke McNamee, Director of Naval Operations; Maj. Gen. Preston Brown, Commanding General, 1st Corps Area; Col. Irving J. Carr, Commandant, Army Industrial College; Col. W. P. Wooten, Director, Army Industrial College; Maj. Gen. John A. Lejeune, Commandant, U. S. Marine Corps; Rear Adm. S. S. Robison, Superintendent, U. S. Naval Academy; Rear Adm. A. L. Willard, Commandant, Washington Navy Yard; Rear Adm. Wm. D. Leahy, Chief, Bureau of Ordnance, U. S. N.; Dr. Chas. G. Abbot, Secretary, Smithsonian Institution; E. R. Fish, Vice-President, American Society of Mechanical Engineers; Hobart S. Johnson, Director, American Society of Mechanical Engineers; the following officials and delegates of the Association of Military Surgeons of the United States: Col. F. H. Vinup,

Annual Meeting of the Army Ordnance Association, Aberdeen Proving Ground, October 4, 1928.

Col. J. R. Kean, Brig. Gen. Wm. H. Wilmer, Col. Chas. R. Reynolds, Maj. E. R. Hume, Dr. Salvadore P. Marraquin, Dr. P. Koryllos, Comdr. Surg. A. B. Estenes, Surg. Capt. Ken Hosomi, Rear Adm. H. C. Whiteside, Jan Ciechanowski, and Col. G. Cantamessa; the following officials of the American Institute of Electrical Engineers: F. J. Chesterman, E. B. Meyer, and E. C. Stone; Col. Edw. A. Simmons, President, Construction Division Association; G. S. Brainard and W. R. Tyson of the Ammunition Advisory Council.

THE program began with a word of welcome by Col. C. M. Wesson, Commanding Officer of the Proving Ground, followed by maneuverings and firings of the 16-inch seacoast gun on barbette mount, the 12-inch gun on railway mount, and antiaircraft firings at towed targets by the 62nd Coast Artillery (A. A.) regiment from Fort Totten, N. Y., using latest types of antiaircraft matériel. These were followed by the dropping of 600-lb. demolition bombs for water impact. The visitors then proceeded to the aviation field where foreign bombs and the several types of bombs developed by the Ordnance Department since the World War were exhibited. Here aircraft of the Army Air Corps were on display. This portion of the program was followed by parachute jumping.

At 12:10 luncheon was served by the Quartermaster Corps of the Army. The orderly handling of the large crowd during luncheon and the well organized arrangements for quick and satisfactory service in this connection were commented upon by many guests.

The afternoon program began as scheduled at 1:10 P. M. and included maneuvering of automotive matériel—tanks, motor gun carriages, tractors, cross-country cars, and dynamometer equipment. These exhibitions were featured by a tug of war between a Caterpillar "60" vs. a 10-ton artillery tractor and a Fordson tractor and also by an attack of a platoon of medium tanks firing ball ammunition against obsolete Renault tanks.

The visitors were then given a demonstration by the new mechanized field artillery contrasted with horse-drawn equipment. Occupation of position, opening of fire and subsequent movement forward were executed by a battery of horse-drawn artillery, Battery D, 6th Field Artillery, and a battery of tractor-drawn artillery portée, Battery B, 6th Field Artillery. Then followed demonstrations of field artillery matériel and artillery ammunition.

AT 3:25 a flight of nine bombardment planes of the 2nd Bombardment Group, Langley Field, Va., and seven pursuit planes of the 1st Pursuit Group, Selfridge Field, Mich., gave the following spectacular exhibitions: attack of targets by pursuit planes using machine guns, demonstration of formation flying, aerobatic flying, and individual combat by pursuit planes, attack of ground target by individual bombing planes using 300-lb. bombs, attack of ground target by formation of nine bombing planes using 300-lb. bombs, and demonstration of laying of smoke screen by pursuit planes.

Supper was served at 5:15 and was followed by a program of night firings of antiaircraft weapons against targets towed by airplanes. Latest types of guns, searchlights and fire-control equipment were used.

At 7:30 P. M. the program was brought to a close and special trains which had brought visitors from New York, New England cities, Pittsburgh and other points, departed.

THE tenth annual business meeting of the Association was held at 4:10 P. M. in the Administration Building. Benedict Crowell, of Cleveland, Ohio, President of the Association, presided. On the rostrum also were Vice-Presidents William W. Coleman, of Milwaukee, Wis.; and William C. Spruance, of Wilmington, Del.; directors, C. L. Harrison, Cincinnati, Ohio; Chas. H. Tenney, Boston, Mass.; Pliny E. Holt, Stockton, Calif.; John C. Jones, Philadelphia, Pa.; James L. Walsh, New York, N. Y.; Ralph M. Dravo, Pittsburgh, Pa.

Following is a transcript of the proceedings:

MR. CROWELL: "I desire, first, to say a word of welcome to the members of the participating societies who are with us today: The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, The Association of Military Surgeons and the Construction Division Association. It is a real pleasure to greet

you and thank you for the interest and coöperation you have given not only by your attendance here today but also for the far-reaching effect I am confident your presence indicates.

"Next I want to make particular mention of the excellent coöperation of the entire War Department not only in the affairs of the Association but particularly in the success of this meeting. The Secretary and the Assistant Secretaries are—as they always have been—most energetic in the assistance given us. Through the personal direction of Assistant Secretary Davison we were enabled to have on the program the spectacular Air demonstration which we have just witnessed. Every officer of the Ordnance Department and all the other branches has given us ideal coöperation, and I take this opportunity publicly to thank Colonel Wesson, Commanding Officer of the Proving Ground, for what I believe is the best arranged, best organized, and best conducted program we have ever had.

"Today's demonstrations and this meeting mark the tenth birthday of the Army Ordnance Association. That the years which have passed since this organization was founded represent a period of importance in matters of national defense is not to be denied. I believe that our Association has fulfilled its function to the best of its ability and with some degree of success.

"Since 1923 our membership has steadily increased to the point where today our total enrollment of 3,361 represents a net gain of approximately 88 per cent over 1923. Our new form of group memberships has been very enthusiastically received; we now have 57 companies on the rolls. Our local posts are a great help in our work. We now have 10 active local posts. In this connection I am happy to announce that due to the interest and guidance of William W. Coleman, our senior vice-president, a post was organized last week in Milwaukee.

"In view of the sound financial condition of the Association, the officers and directors have agreed that it is advisable that the organization be incorporated. Articles of incorporation have been drawn up by Gen. John Ross Delafield and we hope to have the actual incorporation completed before the end of the year.

"One of the principal objectives of the Association as contained in our constitution is 'to provide when required the services of competent committees to investigate and report upon special ordnance subjects.' I have always thought it advisable that we have standing committees of this nature available at all times to render every possible assistance to the Ordnance Department upon such technical or scientific matters as may be referred to them. With the approval of General Williams I have decided to appoint these committees and hope that they will be of constructive service to the Department. After consulting the presidents of our local posts I have selected the members to serve on these committees. I will ask the Secretary to read the Committee assignments.

THE SECRETARY: "*Committee on Artillery:* George L. Gilmore, Lexington, Mass.; W. W. Moody, San Francisco, Calif.; W. W. Coleman, South Milwaukee, Wis.; R. T. Hazelton, Cincinnati, Ohio; E. D. Campbell, St. Louis, Mo.; Frank B. Bell, Pittsburgh, Pa.; C. W. Heppenstall, Pittsburgh, Pa.; H. F. Wahr, Pittsburgh, Pa.; Ross R. Harrison, New Brunswick, N. J.; Maj. L. H. Campbell, Washington, D. C., *Secretary.*

Committee on Small Arms: Nathaniel C. Nash, Jr., Boston, Mass.; E. N. Moor, San Francisco, Calif.; W. A. Tewes, Montvale, N. J.; R. R. Stephens, St. Louis, Mo.; H. H. Hall, Edgewater, N. J.; J. J. O'Connell, New York City; John W. Hession, New York City; Calvin H. Goddard, New York City; Charles O. Gunther, Hoboken, N. J., *Secretary.*

Committee on Ammunition and Explosives: James F. Monaghan, Boston, Mass.; Dozier Finley, Berkeley, Calif.; O. H. Wurster, Chicago, Ill.; A. H. Pugh, Jr., Cincinnati, Ohio; John F. Queeny, St. Louis, Mo.; G. P. McNiff, Pittsburgh, Pa.; H. B. Rust, Pittsburgh, Pa.; F. W. Sperr, Jr., Pittsburgh, Pa.; Crosby Field, Brooklyn, N. Y.; Dr. C. G. Storm, Washington, D. C., *Secretary.*

Metallurgical Committee: Paul B. Morgan, Worcester, Mass.; Welton J. Crook, Palo Alto, Calif.; T. W. Robinson, Chicago, Ill.; J. H. Nead, Middletown, Ohio; John B. Strauch, St. Louis, Mo.; Stephen L. Goodale, Pittsburgh, Pa.; G. Elkins Knable, Pittsburgh, Pa.; C. B. Murray, Cleveland, Ohio; C. E. MacQuigg, Long Island City, N. Y.; Carlos de Zafra, New York City, *Secretary.*"

Mr. Crowell: "In closing this brief report on the status of the Association I merely wish to reiterate the thought that we have ten years of successful accomplishment behind us; let us all strive to make the coming years even more successful. This we can do only by the constant application of our best thought and coöperation to the purpose for which we were founded—'adequate industrial preparedness for war as the Nation's strongest guarantee of peace.'

"Before calling on the speakers who are scheduled to address this meeting, I would like to ask Dr. C. G. Storm, Washington, D. C., Chairman of the Committee of Tellers who canvassed the ballots in our recent biennial election of officers and directors, to present the report of his committee."

DOCTOR STORM: "On behalf of the Committee of Tellers of Election appointed by the President pursuant to Section 13 of the By-Laws of the Association, I desire to present the following report:

"The Committee of Tellers, consisting of Maj. Kenneth B. Harmon, Capt. Charles Demonet and myself met in the office of the Association on September 6th and canvassed the ballots cast by members entitled to vote in the biennial election of officers.

"The results of the canvass are the almost unanimous reëlection of the following:

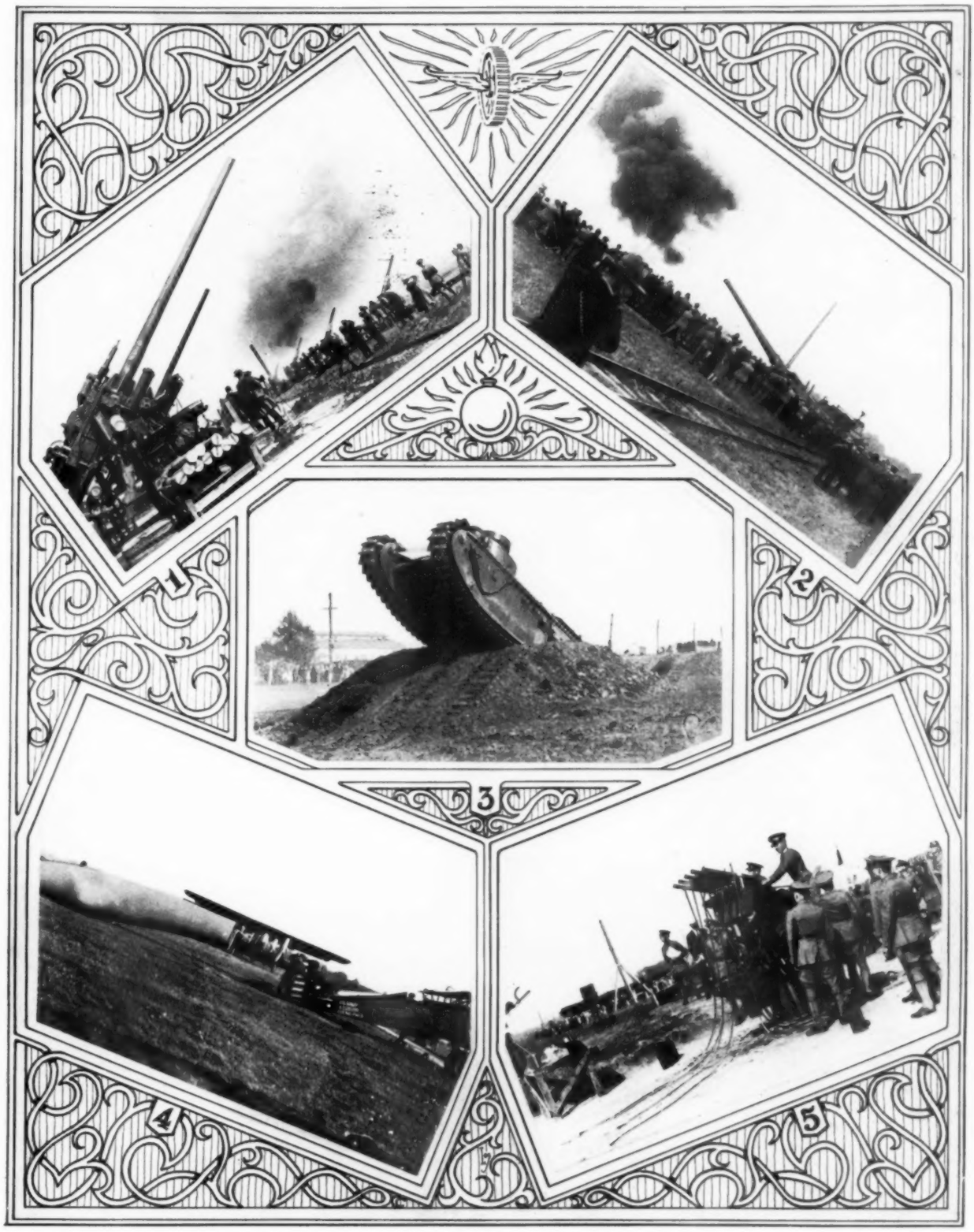
President (to serve until December 31, 1930): Benedict Crowell, of Cleveland, Ohio.

Vice Presidents (to serve until December 31, 1930): William W. Coleman, of Milwaukee, Wis.; William C. Spruance, of Wilmington, Del.

Directors (to serve until December 31, 1932): Robert P. Lamont, of Chicago, Ill.; Frank A. Scott, of Cleveland, Ohio; C. L. Harrison, of Cincinnati, Ohio.

"Seventy-three ballots were found defective and were rejected.

"The proposed amendment to the Constitution making students of all engineering and technical schools and colleges eligible for junior membership was adopted."



Scenes at the Tenth Annual Meeting.

1. During the morning antiaircraft firings. Battery of 3-inch guns shown in action. The new 105-mm. antiaircraft guns in the foreground. 2. Firing the 16-inch seacoast gun. Photo shows the gun and some of the spectators an instant after the projectile left the muzzle. 3. The medium tank—latest development of the Ordnance Department in this class of vehicle—negotiating an obstacle during the automotive demonstrations. 4. A sleeve target used by the Air Corps fliers in the day and night antiaircraft firings. 5. Machine guns on multiple mounts used in the antiaircraft demonstrations.

Mr. Crowell: "Thank you, Doctor, for the work and the report of your Committee.

"General Williams, our Chief of Ordnance, who needs no introduction to our members, will now address us on the subject 'Ordnance Since the World War.' General Williams."

GENERAL WILLIAMS: "I am pleased to have an opportunity to address this Tenth Annual Meeting of the Army Ordnance Association. This occasion is a very significant one in that it comes very nearly at the tenth anniversary of the ending of the World War. During the past ten years those of us who are interested in munitions preparedness have witnessed a remarkable advancement in our policy of national defense. We have seen the establishment of a new idea which has come to be called industrial preparedness, by which we mean the keeping of American industry in such a condition that it will be able to produce in the shortest possible time the munitions necessary for arming our troops should there be another war.

"The Army Ordnance Association has been of untold assistance in this work of the Department and I desire to pay this tribute to Mr. Crowell personally who, after the World War while Assistant Secretary of War, saw to it that the authority for industrial preparedness as we have it today was incorporated in the National Defense Act under which the Department operates. It is most stimulating to me as Chief of Ordnance to have the loyal and steadfast coöperation of the officers and directors of the Association, the District Chiefs, the entire Association, and those other national organizations, some of which are participating in this meeting.

"To give you a brief summary of the status of Ordnance advancement since the World War, I consider the principal developments to be: 1. Antiaircraft and field weapons; 2. Motorization, often referred to as mechanization; 3. Ammunition, and 4. Small Arms.

"AS to the first classification, antiaircraft and field weapons, the test of the 3-inch antiaircraft gun on fixed mount was concluded last year. This four-gun battery was fired over 10,000 rounds with practically no failures. These tests demonstrated that the gun and carriage represent fully developed matériel which can be issued to the service with confidence.

"During this period an entirely new system of fire control for antiaircraft guns has been developed, manufactured, and tested. The whole system is known as the Case III method of fire. The Case I system, formerly employed, will no longer be used.

"The antiaircraft fire-control director used in today's firings automatically, by mechanical and electrical means, delivers to the gun the data for laying the gun for firing. The performance of this instrument is being compared with that of the director designed and developed by the late Maj. W. P. Wilson of the Ordnance Department. The brilliance of Major Wilson's work on this antiaircraft director is well appreciated, I believe, by the officers of the Ordnance Department, and it is a severe loss to the Department that Major Wilson's work has been interrupted by his untimely death. The Department will endeavor to carry on Major Wilson's work to the best of its ability.

"Two 105-mm. antiaircraft guns and carriages were provided for this year's program. The 105-mm. gun is the longest gun in calibers (60 calibers long) manufactured to date in this country. This gun was made by the cold-worked process and is equipped with a loose liner. The tests indicate that the 105-mm. matériel is destined to perform an important role in antiaircraft defense for attacking planes at high altitudes and long ranges. The using service has found that the 105-mm. gun and mount are satisfactory, and these units are now standards of manufacture.

"The 3-inch antiaircraft gun and mobile carriage were completed in time for test here last year. The gun and carriage were found to be satisfactory by the using service and are now being standardized.

"Several of the antiaircraft guns used during the tests were manufactured by the cold-worked process. These guns have proven entirely satisfactory, as have all of the forty or more guns of various calibers which have been built in the last four years by this method. The 3-inch and 105-mm. guns are provided with loose liners, which can be removed and replaced in the field by the using service. The development of the loose liner for the antiaircraft gun is believed to be of first importance, since this method of gun construction permits the worn-out gun to be quickly relined, thus making the use of high muzzle velocities practicable.

"By applying electrical data transmission and follow-the-pointer systems to machine guns, and by the use of more exact fire-control instruments, the percentage of hits with machine guns has been more than doubled, giving indications that future development of fire-control instruments will result in improved accuracy and volume of fire.

"By the close coöperation of the Chief of Coast Artillery and the Ordnance Department, and by the two extensive firing tests held at the Aberdeen Proving Ground, with regular antiaircraft troops, it has been possible in two years' time to evolve entirely new antiaircraft guns, carriages, and fire-control equipment. The major items of this matériel have been standardized and the Department stands in a position to equip our antiaircraft regiments, when funds are made available, with highly developed matériel, the efficiency of which has been fully established by extensive firing and maneuvering tests.

"The development of mobile artillery matériel since the close of the World War has been generally along the lines of the approved recommendations contained in the Caliber Board Report. These nine years consequently have been a period of intense activity in artillery development for the Ordnance Department, as greatly improved weapons of every caliber required by the Army, were called for. The characteristics prescribed by the Caliber Board Report for these new weapons were far in advance of any known existing types.

"Design work was promptly inaugurated, and by 1921 the first pilot units began to arrive here at Aberdeen Proving Ground for test. These first attempts to produce new weapons to meet the stringent requirements of modern warfare, while not entirely satisfactory, were in many ways most gratifying. It was found that we could build cannon having greatly increased ranges and accuracy, and at the same time keep the weights within the limits imposed by the demands for mobility.

"In connection with these developments it was necessary to evolve and perfect many very important basic features

of design, such as, whether or not the field carriage should mount interchangeably both a gun and a howitzer; the relative merits of the box trail and the split trail types of carriage; the limits of elevation and traverse necessary for guns and for howitzers; and the methods of transporting the heavier calibers, whether in single or divided loads. The combat branches and the Ordnance Department have been drawn very closely together by their mutual interests in this absorbing subject of developing improved matériel, and we appreciate very greatly the fine spirit of understanding, assistance and coöperation which has been shown the Ordnance Department by the using services.

The Secretary of War, Members of the Cabinet, Ranking Members of the War Department, Officials of the Army Ordnance Association, and Industrial Leaders with Major Georges Scapini (center, first row), Blind French Veteran and Member of the French Chamber of Deputies, at the Aberdeen Proving Ground, Md., for the Tenth Annual A. O. A. Meeting.

"From the time of the first appearance of these new pilot weapons, great progress has been made in the gradual evolution toward improved, practical weapons having the characteristics required by the Caliber Board Report, and at the same time embodying rigidity, strength, and maneuverability necessary for successful service weapons. This extensive artillery development program is now nearing completion, and many of these newly developed artillery weapons are being standardized and adopted by the War Department as new service types. Generally speaking, some preference has been given to perfecting the artillery weapons accompanying divisional troops. Work on the heavier corps and army types, however, has been carried on as rapidly as funds would permit, and the final perfection and adoption of these new heavy types should follow very closely the adoption of the new light types.

"For use with the Infantry, two new weapons recently have been adopted by the War Department: a 37-mm. gun of greater power than the present service type, and a 75-mm. mortar to replace the inaccurate and short range Stokes trench mortar used during the World War.

"A new 75-mm. pack howitzer has been adopted and the first battery of this matériel was issued to the Field Artillery in the spring of 1927. This 75-mm. pack howitzer matériel culminates at least twenty years of effort on this design. This howitzer has a range of 9,000 yards, and replaces the old Vickers-Maxim 2.95-inch mountain gun of the Spanish-American War period, with its very inadequate range of approximately 4,500 yards.

"The first battery of the new 75-mm. field guns was issued last fall to the School of Fire at Fort Sill, Oklahoma. This new carriage is of the split trail type with a traverse of 56 degrees and a maximum range of 15,000 yards.

"The 105-mm. howitzer is a new caliber in our Army, and consequently every possible effort was concentrated on its development. This 105-mm. howitzer matériel of the split trail type has a maximum range of 12,000 yards with a 33-pound projectile, and should prove a most effective companion piece for the 75-mm. gun for divisional artillery. This new matériel has been standardized recently; and the first units are being exhaustively tested both by the Field Artillery Board at Fort Bragg, North Carolina, and by the Aberdeen Proving Ground, Maryland, in order that any minor corrections in design may be made prior to the manufacture of additional batteries.

"The new corps weapons are a 4.7-inch gun and a 155-mm. howitzer. The 4.7-inch gun, Model 1921, has been extensively tested both by the Ordnance Department and by the Field Artillery Board for the past five years, and minor corrections made in a design which on the whole has proven highly satisfactory. This new 4.7-inch gun has a range of approximately 20,000 yards as compared with a range of less than 9,000 yards for our old 4.7-inch gun, Model 1906. The total weight of this new matériel of less than 6 tons makes it a highly mobile unit.

"The first unit of the latest design of 155-mm. howitzer has recently been tested here at the Proving Ground. This new howitzer, weighing approximately 8 tons, has a maximum range of over 16,000 yards; in other words, when compared with the 155-mm. G. P. F. gun used during the World War, this new corps howitzer has almost the range of the G. P. F. gun with only a little more than half of its weight.

"The new army weapons are a 155-mm. gun with a range of 25,000 yards, and an 8-inch howitzer with a range of more than 18,000 yards, which can be mounted interchangeably on the same carriage. To increase the mobility of this matériel, the gun or howitzer is removed from the carriage for traveling and carried on a separate transport wagon. This brings the weight of the carriage load to less than 20,000 pounds, so that this load can be drawn readily by the commercial 10-ton tractor. This new matériel has been tested thoroughly for several years, and with minor changes, is found to be very satisfactory. It is planned to manu-

facture and test a second unit incorporating new design features before recommending this matériel as a new standard for adoption by the War Department.

"It is thus seen that we now have for the divisional troops a complete new line of artillery matériel adopted by the War Department; and for the corps and army artillery very satisfactory new types, all of which are approaching standardization.

"For the fixed harbor defense artillery, the 16-inch gun and the 16-inch howitzer matériel are our standard equipment.

"The post-war development of railway mounts calls for a large railway carriage mounting either the 14-inch gun or the 16-inch howitzer, and a smaller carriage to mount either the 12-inch howitzer or an 8-inch gun. The larger mount for the 14-inch gun has been developed, and the fourth of these new mounts is now completed and is at the Watertown Arsenal. The smaller mount is now undergoing its final proof testing at the Aberdeen Proving Ground.

"A large amount of splendid development work on new types of artillery matériel has been accomplished. Along with the development of types has been carried improvement in the processes of manufacture, the most outstanding of which is the autofrettage or cold-worked method of constructing cannon. All of the smaller calibers up to and including 6-inch have now been manufactured successfully by this new method. All drawings of recently adopted equipment have been prepared with a view to their use in quantity production manufacture. The Ordnance Department is now in the enviable position of being able to supply our Army with artillery matériel second to none in case of an emergency.

"WITH reference to motorization, or mechanization, during the past year very marked progress has been made in our automotive development program. The preliminary design of a light tank chassis was approved in December, 1926. In the following April the contract for its manufacture was awarded to the Cunningham Motor Car Company. One hundred and eight days later the chassis was operated under its own power.

"The Medium Tank 23-ton TI has been completed, and after shop tests at Rock Island Arsenal, has undergone a Proving Ground test of 400 miles. The tank is now undergoing tests at Camp Meade by the Tank Board, and we understand that it has given a favorable impression. The characteristics of the tank as regards weight, speed, armor and armament are practically identical with those of the Medium tank Model 1921.

"Tests of various commercial tractors and trailers have been carried on throughout the year by the Proving Ground, and by the various Service Boards, in order that we may keep well informed as to the suitability of commercial types.

"Two standard one-ton Chevrolet trucks have been modified by the addition of a rear driven axle, and are now under test by the Field Artillery and Infantry Boards. This development is an effort to secure a light truck suitable for cross-country maneuvers.

"The cross-country car is being well received by the service, and a few additional units have been issued.

"WITH regard to the third classification, ammunition, the most outstanding event affecting our ammunition problem during the past year was the passage by Congress of a bill which was signed by the President, appropriating and making available immediately $2,300,000 for the rehabilitation of the Picatinny Arsenal. In rebuilding the arsenal, there will be incorporated the most modern improvements which experience has shown to be advisable. When completed, in addition to serving as an arsenal where our experimental and development work on high explosives, loading, etc., may be conducted, and where a limited quantity of explosives and loaded ammunition may be produced, it will serve as a school where, in time of an emergency, our inspectors may be trained properly and where our contractors may learn how to make safe and efficient ammunition.

"Nitrates are fast being removed from the class of strategic war materials because of the development and perfecting of methods of fixation of atmospheric nitrogen.

"Although the work at Picatinnny Arsenal was greatly handicapped by the limitations of the facilities available, a considerable number of experimental samples of FNH powder have been manufactured for ballistic tests in the entire series of weapons ranging from 37-mm. to 155-mm.

"In addition to the FNH power for the 75-mm. gun, Model 1897, and the NH powder (not flashless) for the 155-mm. G. P. F., both of which have been declared standard, the du Pont Company has produced satisfactory FNH powders for the 75-mm. pack howitzer, the 105-mm. howitzer, and the 2.95-inch mountain gun. Considerable progress has been made toward the development of satisfactory powders for the 75-mm. gun MI and the 3-inch antiaircraft guns. Both Picatinny Arsenal and the du Pont Company are continuing their efforts further to improve a number of these powders and to develop suitable powders of this type for other weapons. Each of these organizations works independently of the other and on compositions of different type.

"The development of a flashless, non-hygroscopic powder has required a re-study of the ignition problem, since a number of the compositions which meet the requirements for non-hygroscopicity are more difficult to ignite than the present pyro powder. It has been determined that the method of ignition exerts a great influence upon the flashless characteristics, probably fully as much as the composition of the powder itself. It is improbable that a satisfactory substitute for black powder for ignition will be developed in the near future. Black powder seems to have certain characteristics which make it particularly suitable for ignition purposes.

"In addition to tests in connection with ignition, there have been undertaken at the Aberdeen Proving Ground many other projects involving basic research; such as, effect of powder temperature on velocity and pressure, velocity and distribution of shell fragments, effect of moisture in powder on ballistics, etc., and data of general and permanent value have been obtained.

"The early satisfactory production of boosters was one of the stumbling blocks in our war-time munitions program. To facilitate the manufacture of booster casings, several new methods of production have been investigated. Certain companies which made booster casings during the war have furnished, willingly and at considerable trouble and expense to themselves, valuable information. As a result of the study which has been going on, Frankford Arsenal, after a long period of experimentation accompanied by

many discouragements, has now been given an order for the production of several thousand casings and it is hoped will soon be in a position to furnish full manufacturing information to the district offices.

"Due to difficulties in mass production, handling and shipping, the false ogive type of shell is being replaced wherever possible, without too great sacrifice in range, by the one-piece type.

"Improved methods of production are still under investigation but it appears from the work accomplished to date that the conventional shell forging from pierced billets still holds its own in the light of recent developments in this field.

View at the Main Front During the Automotive Demonstrations.

"It has been established that satisfactory shell can be produced from steel tubing. Whether such shell can be produced more rapidly than the forged shell has not yet been proved. This will be determined as soon as sufficient tube shell can be made. Since sufficient quantities of forged shell can eventually be obtained with certainty, the use of any other type depends almost wholly upon the comparative rapidity of production.

"In bomb construction it has been found possible to eliminate as separate parts the nose and tail castings and to make a one-piece bomb body without joints or seams, except those necessary for the nose and tail fuze, and a small closing cap at the rear end.

"Experimental designs of cylindrical type demolition bombs eventually to replace the present standard streamline demolition bombs have been completed on the 100-pound, 300-pound, 600-pound, 1,100-pound, and 4,000-pound sizes; the 2,000-pound size has already been standardized.

CONCERNING the fourth and last classification, small arms, during the past year twenty of the new Pedersen caliber .276 semiautomatic rifles were completed by Springfield Armory and turned over to the Infantry and Cavalry Boards for service test.

"Springfield Armory has manufactured a .276 semiautomatic rifle according to the designs of Mr. Garand. This will be available for the competitive test to be held in the near future. This is one of the most important projects of the Ordnance Department. In view of the great number of designs which have been tested in the past and the amount of time which has been consumed in arriving at a decision on this matter, it has been decided to hold a competitive test on a date to be announced later in order that all inventors and manufacturers may have an opportunity to submit their weapons to the Ordnance Department for competitive tests. The Ordnance Department will submit an improved Garand type and a Pedersen type for competitive test with the weapons designed and furnished by inventors and manufacturers.

"The War Department has appointed a board of officers for the purpose of supervising the test. As a result of the semiautomatic rifle development, it is believed we will also obtain a suitable design for a receiver sight to be used not only on the semiautomatic rifle but which also may be applied to the Springfield rifle in case it is so desired.

"Extensive experiments are being made on caliber .50 machine guns in an endeavor to increase their efficiency and improve their use for antiaircraft work. New flash hiders were designed for the caliber .30 and caliber .50 machine guns and gave satisfactory functioning during the antiaircraft exercises.

"A new type of aircraft machine gun which can be used both as a fixed and flexible gun, with right or left hand feed, and having many other improvements over the Model 1919 type has been developed and will soon be furnished the Air Corps for test.

"In view of these accomplishments I believe all of us have cause for righteous pride. As Chief of Ordnance I say without qualification that this record is due in large measure to the excellent morale and technical ability of the officers and civilian employees of the Ordnance Department, the splendid coöperation of American industry, and the constant help of the Army Ordnance Association."

Mr. Crowell: "General, I am confident that all of us are very proud of the fine record American ordnance has made under your capable guidance.

"We will now have an address by Mr. James L. Walsh who, as Chairman of the National Defense Division, American Society of Mechanical Engineers, will speak on "Practical Preparedness." Mr. Walsh, as many of you know, was one of the founders of our Association and is entitled to much credit for the successful establishment of the organization. He was Secretary of the Association from 1919 to 1923, and is now a director representing the New York Post, Army Ordnance Association, of which he is president. He is also Chief of the New York Ordnance District. Mr. Walsh."

MR. WALSH: "General Williams, Mr. Crowell, Members of the Army Ordnance Association, and participating Societies:

"I think that I am but voicing the sentiments of all the members of the American Institute of Electrical Engineers, the Construction Division Association, the Society of Military Surgeons of the United States, and the American Society of Mechanical Engineers, who have been present here

Landing via Parachute—Feature of the Spectacular Air Corps Program at Aberdeen, in which Planes from Langley Field, Va., and Selfridge Field, Mich., took part.

today, when I say that we all have had one of the most interesting and enjoyable days of our lives.

"However, our casual interest and personal enjoyment are not worth the tremendous effort that the Army Ordnance Department and the Army Ordnance Association have made today—unless we take away with us some thoughtful reflections as to the magnitude and complexity of the great Ordnance problem, some appreciation of the difficulties being encountered, and some determination to be of assistance in the effort to effect a solution.

"As engineers, many of us, in civilian life, have gained an intelligent appreciation of the difficulties to be surmounted in attaining quantity production of a new article. We are amazed, I might almost say, we are bewildered at the number and variety of modern tools of war.

"We see the dough-boy's shoulder rifle; and reflect that millions of them would be required in the event of a major emergency with cartridges running into the billions. We see machine guns, firing bullets four times as heavy to twice the maximum range which was attained during the World War; and note the trend toward greater and greater use of machine guns and automatic rifles to increase the volume of fire per man. We sense that this may mean the requirement of small arms ammunition in quantities as yet perhaps beyond any reasonably approximate computation.

"We examine 75-mm. guns, which would be required by thousands; and then mentally calculate the number of machine shops which could be readily adapted to the production of hydro-pneumatic recuperators—probably the most highly accurate piece of forging, machining, lapping and finishing, which we would be liable to encounter in the course of our natural lives. We sense the importance of adequate field artillery ammunition supply for the preliminary bombardment and rolling barrage necessary to conserve our infantrymen moving forward to attack the enemy's position.

"We witness firing of the great 16-inch gun, designed for the protection of our home ports; and mentally note that today there are probably not more than three horizontal boring mills in the whole United States capable of handling the 27 foot-in-diameter racer and base-ring. These huge castings must be finished to a high degree of accuracy, in order to yield that ease and accuracy in elevating and traversing, without which the entire investment would be ineffective and perhaps worthless. We wonder how many gun-lathes are left in the United States capable of swinging the 150-ton gun itself for the highly accurate boring and rifling operations prerequisite to effectiveness in action.

"By the way, as you may know, we have been honored with the presence of four members of the Cabinet today. We wish the Treasury Department could have been represented and then, perhaps, we would have some assurance that a regrettable incident of a few years ago would not happen again. The incident I refer to is this: One of our very large corporations possessed ten gun-lathes left over from the World War. Each machine cost about $250,000. This corporation patriotically offered to preserve these gun-lathes in the interest of National Defense but our Income Tax Bureau would not allow the corporation to write them down to their true commercial value to the owners which, as you can imagine, was very little. The corporation was not allowed to take credit on its income tax return, unless the whole $2,500,000 worth of priceless ordnance machinery was actually destroyed and reduced to scrap. What a short-sighted policy it was for one bureau of our Government to be endeavoring to build up the machine tool resources necessary to solve this tremendous problem, while another bureau was insisting upon the destruction of valuable assets to the National Defense.

"We have also gazed with wonderment upon the range-finding and altitude-finding matériel, designed for the anti-aircraft protection of our larger cities. We have often heard the expression that a machine seems almost human. In this case, we confess these intricate mechanisms are more than human. They perform necessary functions heretofore assigned to personnel, and perform them far more quickly and far more accurately.

"While on this subject of fire-control matériel, and having in mind the highly intricate mechanism just referred to, it might be apropos to remark that during the World War a contractor, who possessed more patriotic zeal than knowledge of the situation, was insistent in his demands that he be awarded a very large contract for fire-control matériel. He claimed that his plants had had plenty of experience in the manufacture of fire-control matériel and he was sure that he could handle a sizable job in its production. It developed that he was, as a matter of fact, a very large and successful manufacturer of fire-extinguishers—those little blue bottles we used to see hanging on the walls of office and factory marked 'For use in case of fire only.'

"WE are deeply sensible that practically every implement of war we have seen in action today is essentially noncommercial—that it has no parallel peace-time product upon which our manufacturers can practice against the day when they might unhappily be called again into the service in defense of our country. As the result of our peace-time activities we know how to feed men; to clothe them; to house them; to transport them by rail, by boat, by horse or motor; we know how to provide them with the quickest means of communication by telephone, telegraph or radio; we know how to handle the money necessary to pay them; we know how to provide them with the best medical, surgical and dental care.

"As a matter of fact, due to the greatly aroused interest in air travel as a result of the epoch-making flights of Lindbergh and his like, together with the putting into effect of the wise recommendations of the Morrow Board, which has resulted in a tremendous stimulation of the aircraft manufacturing industry, it can probably be said with truth that the problem of providing aircraft is well on its way toward ultimate solution.

"But with the solution of all these problems well in hand and even considering the fact that we have 17,000,000 men of military age in the country, can we honestly say that we have achieved preparedness? The answer is emphatically "NO"—not until the Ordnance problem has been advanced towards solution in a like degree.

"We are quite willing to agree, as a result of our observations here today, that the design and development phase has in general, as just pointed out by General Williams, been carried successfully to the point where we can say confidently that type for type, down through the whole family of articles of ordnance, our shoulder rifles, our machine guns, our field guns, our coast defense cannon, our tanks, our bombs, our ammunition, and all the innumerable accessories incident thereto, not only represent tremendous advances over similar types employed during the World War, but also compare favorably with anything developed by any foreign nation. For the successful execution of this program of design and development, General Williams and his fellow-officers are entitled to our sincere congratulation and our heartfelt appreciation for their substantial contribution to National Defense.

"We learn upon inquiry, too, that the requirements for a modern army have been worked out in great detail, the computations requiring the full-time service of over fifty officers for something like two years. Apparently, we not only know what type weapons we want, but how many of each kind, which is more than we knew at the beginning of the World War. This in itself is a great contribution not only to the effectiveness of the armies in the field by providing adequate supplies, but it also tends to lessen the burden on the taxpayers at home, through preventing wasteful overordering with a consequent unnecessary dislocation of industry. But to know what ordnance we want and how much ordnance we want is not enough; we must also know how to produce it promptly in emergency; that's where we get right down to the nub of the whole question.

"AS you all know, the country has been divided into fourteen industrial districts. To each district has been allocated a certain quota of various articles of ordnance, which the civilian factories in that district can supply most promptly and in the greatest quantities. We would be only fooling ourselves if we should witness these firings today, and gain the impression that the ordnance problem has been completely solved. We have seen only the culmination of ten years' intensive work of design and development. But back of all this noise and smoke, I wonder how many of us realize that, during the past five or six years, there has been going on slowly, but with increasing momentum, a program for the training of Ordnance Reserve Officers and, in parallel with it, a complementary program for the education of industry for the manufacture of these noncommercial articles, without which our boys would be nothing more nor less than cannon fodder.

Maj. Gen. C. C. Williams, Chief of Ordnance, U. S. A., and Dwight F. Davis, Secretary of War, Inspecting one of the Fire-Control Instruments at Aberdeen.

"In one district comprising some 200 ordnance reserve officers, meetings are held every Monday evening from October 1st until the middle of May. Plain, ordinary American citizens who have done their full day's work for themselves or their civilian employers, devote one evening a week to conscientious work studying the intricacies of Government contracts, discussing the niceties of quantity manufacture of these noncommercial articles you have seen today. They are not paid for this work as are members of the National Guard. There are no flags waving, nor bands playing to stir their military ardor. It is just slow, hard, plugging work, in little groups in the larger cities, or by correspondence courses alone at home.

"How many of us know or appreciate the work that many of our corporations are doing to prepare complete factory plans to be put into effect in the event of emergency. They are spending time, energy and funds without thought of public appreciation, and, if I must say it, in some cases, in the face of cynical sneers as to their motives. They are doing all this actuated by the highest type of peace patriotism. They have as their reward only the sense of duty well done. And this reward is all that they ask.

"THE World War cost us a million dollars an hour for over two years. That figure covers direct outlay only. If we figured in the interest on war expenditures until today only, the figure would be increased to a million and a half dollars per hour. As a matter of fact, our war debt is not yet extinguished and, even with the most optimistic computation, it is probable that the final cost would approximate a basis of two million dollars an hour. Just stop and think what that means—two million dollars an hour, twenty-four hours a day, for over two years. Is it worth while to make the effort to see that this terrific tax burden shall never again be yoked on the necks of succeeding generations? If we could, by doing now the things that can and should be done prior to the outbreak of war—if we could but shorten the duration of the next conflict by twenty days—we would save those who come after us, the round sum of one billion dollars.

"As technical men, we are willing to venture the opinion that the design and development work which we have seen come to fruition in today's firings—the mere establishment of standard types—has saved at least twenty days of the endless backing and filling that characterized our most recent wasteful attempt to improvise munition supply. Also as technical men, I think we could hazard a guess that the determination of requirements—the fixing of how much or how many of each article will be required—has probably saved another twenty days of the unnecessary indecision and inaccuracy, which slowed up and made wasteful the gearing up of the huge industrial machine which we found necessary at the outbreak of the World War. On the World War basis of costs, it strikes us that you gentlemen have already saved future taxpayers some two billions of dollars in the unfortunate event of the recurrence of another major emergency.

"Are still further savings possible, and, if so, how can they be secured? As technical men can we fully comprehend that time is required to convert blue prints into finished articles; that the best factory plans in the world contain 'bugs' which hold up production; and that these 'bugs' can only be removed by putting through the factory small experimental lots for the express purpose of ironing out the wrinkles which always have and always will creep into mere paper plans. The remedy is fortunately a simple one; viz., the placing by the Government of 'Educational Orders' not on a competitive basis as to price, but giving due consideration to the knowledge acquired by the manufacturer which, after all, is what the Government wants.

"WHEN all is said and done, our ordinary peace-time activities include fields of endeavor approximately parallel to war-time functions with two exceptions, viz.: (a) The training of men in the *use* of arms. (b) The training of industrial plants in the *manufacture* of arms.

"For training men in the *use* of arms, we have the Military Academy at West Point, the War College, The Staff Colleges at Leavenworth, the Artillery, Infantry, Cavalry and Aviation Schools, certain portions of the Regular Army not needed for insular garrisons or border patrol, the Reserve Officers' Training Corps units in our civilian colleges, the Citizens Military Training Camps and the National Rifle Matches. All of these are Government institutions supported by Federal and State appropriations.

"All that the Government gets in return for substantial expenditures is the fact that a small number of its citizens have acquired a certain amount of proficiency, either individually or collectively, in the *use* of arms. It would seem to the lay mind equally logical that the Government should be willing to make reasonable appropriations to no other end than that certain of its industrial plants shall acquire the knowledge necessary to fabricate these arms and the ammunition for them; without which our men cannot become soldiers in the full sense of the word.

"Stop and think what the infantryman would be without his rifle, ammunition and helmet—a living target for the enemy; or the artilleryman without his field gun and its shell and shrapnel—a helpless spectator to the slaughter of his comrades in the infantry. Consider the aviator, equipped with even the safest and swiftest airplane that money can buy; what could he do without his machine gun to fight off opposing planes or his bombs to demolish fortified places. Without ordnance, even if he had the best airplane in the world, he would have nothing but a grandstand seat from which to witness the overwhelming defeat of our ground troops. We have heard a lot about airplanes sinking battleships. No airplane of itself, guided by even the bravest of our aviators, ever sank a single battleship; those that were sunk were sunk by ordnance. Without ordnance, the aviator could give the opposing fleet a good hard look and nothing else.

"SO we are going away tonight, General Williams and Mr. Crowell, with the feeling that you have done your part; that the program you have laid out for the solution of this important ordnance problem is a practical one.

"Until we are ready to match our unrivalled man power with adequate and prompt supply of ordnance, it strikes us that we have a weak link in our armor, and all other preparations are not only wasteful but futile. To that great task—the solution of the ordnance problem—I pledge you the earnest, continuing effort and support of the entire membership of the American Society of Mechanical Engineers.

"We, with your help, and that of other societies which have an intelligent understanding of the fundamentals of national defense, we shall during the next few years be successful in obtaining the necessary legislation to permit the placing of Educational Orders with civilian industrial plants in order to enable them to fit themselves for a war-time task and if, at the same time, it shall become possible to very substantially increase the number of trained Regular Army Officers which will be required to put this program into practical effect, I think we can consider resting on our oars, because we will have attained practical preparedness.

"On behalf of the 18,000 members of the National Defense Division of the American Society of Mechanical Engineers and, if I may say so, on behalf of the memberships of the other societies who have joined with the Army Ordnance Association in this meeting today, I want to thank you for giving us this opportunity to educate ourselves to do our part in the grand program for national defense."

Mr. Crowell: "I wish it were possible to call on other members and guests who have matters properly within the scope of this meeting which they would like to present, but we have already extended well beyond the allotted time.

"Gentlemen, this concludes our tenth meeting. Thank you very much for your interest and coöperation."

Erosion of Rifled Bores

By D. C. McNair*

THE problem of gun erosion is one of the most baffling and difficult that ordnance engineers have been called upon to solve. The laboratories and the proving grounds of all nations have been concentrated upon it for years. Efforts have been made to produce the observed phenomena artificially under known conditions in order definitely to determine the causes and permit their removal if possible. Countless devices have been tried in the hope that some might be found which would improve conditions. Modern ordnance represents remarkable progress in design, construction, material, fitness for the intended purpose, ease and rapidity of operation, ruggedness and general effectiveness; but erosion still offers a serious barrier in the path of increased durability and accuracy life of weapons which fire projectiles.

Erosion may be defined generally as the wearing away of the surface of the bore under the action of the powder gases of firing. There are two particular forms of erosion. The first is the gradual enlargement of the bore and the smooth wearing away of the surface by the action of the gas in rear of the projectile. It begins in rear of the rifling and extends farther and farther down the bore as the firing is continued. This wear is greatest at the rear, and is about twice as great on the lands as in the grooves, so that its effect is to make the bore slightly conical from the front of the powder chamber forward and gradually to obliterate the rifling. In the center part of the bore this wear is almost negligible and once more becomes apparent near the muzzle but to a lesser extent than in the rear. The second form of erosion is the irregular eating away of the surface of the bore in pits and gutters, which is called scoring. This form also is more marked at the origin of the rifling, allowing the projectile to be rammed beyond the original seat before the rotating band takes the rifling. It appears in this case also, that the wear of the tops of the lands is greater than that of the bottoms of the grooves, and the driving edges of the lands also are worn somewhat markedly. The forward slope of the powder chamber also shows considerable wear.

OBSERVATION, study and experiment have shown that erosion varies with a number of factors. The greater the temperature of combustion, the greater is the erosion. Nitroglycerin powders develop higher temperatures than nitrocellulose powders, and hence cause greater erosion. Consequently nitrocellulose powders are now in general use, in spite of the fact that they require heavier charges to produce the same propellant effect. The quantity of heat developed, largely a function of the weight of the charge, also is an important factor. Another is the time the projectile is in the bore, which determines the time the bore is exposed to the action of the gases. It follows that, for a given caliber, the erosion increases with the muzzle velocity, since a high muzzle velocity requires a heavy charge and a relatively long bore; hence guns erode more rapidly than howitzers. The surface of the bore increases directly with the caliber, while the charge and the quantity of heat developed increase generally with the cube of the caliber; hence, for a given muzzle velocity, the larger the caliber the greater is the erosion. Erosion increases rapidly with the rate of fire, after passing a rate such that the heat developed can be radiated without increasing the temperature of the bore.

The metal of the tube is still another factor in erosion; the melting point should be as high as possible. Experiments with various steel alloys have indicated that the present mild steel suffers as little erosion as any of the many special alloys which otherwise are suitable for gun construction. It has been found that the erosion increases rapidly with the proportion of carbon in the steel. Hardening the steel by heat treatment has proved ineffective in reducing erosion.

The higher the nitration of the powder, the greater is the erosion. Although a high nitration powder permits the use of a smaller charge, the quantity of heat developed is such that the resultant erosion actually is greater than with an equivalent charge of low nitration powder.

That erosion is of the greatest practical importance is shown by the fact that the accuracy life of a major caliber gun is, in some cases, as low as one hundred rounds, which could be fired in a few hours of action. It then becomes necessary to reline the bore, the difficulty of which is apparent. The latest antiaircraft guns, necessarily of the highest possible velocity, are provided with removable liners which can be replaced without dismounting the gun. In order to maintain the accuracy life of field guns at figures which are practicable, it is necessary to reduce the rate of fire far below that of which the matériel is capable and which would be desirable tactically. Erosion has forced a reduction of the velocity of seacoast guns and the adoption of larger calibers in order to secure the same muzzle energy. While the larger caliber gun with reduced velocity is as powerful as the smaller caliber with higher velocity, the high velocity gun has an important advantage in its flatter trajectory. Against targets presenting a considerable vertical surface, such as ships, a flat trajectory is of the greatest importance; it is vital in the case of naval guns and small arms.

THERE are a number of theories as to the causes of erosion; the effort in every case is to offer a rational and useful explanation of the observed phenomena. Such theories are not exclusive, since it is rarely contended that erosion is due solely to one cause; differences are largely in the importance attached to a particular supposed cause. Competent authorities, supported solidly by service and experimental results, have reached widely different conclusions, which at least testifies as to the complexity of the problem. The various theories may be stated briefly as follows: *First*, that erosion is produced by the highly heated gases of combustion escaping at high velocity

*This paper was awarded first prize in the annual prize essay contest, 1928, sponsored by the Army Ordnance Association for the best essay on an ordnance subject submitted by a member of the First Class, United States Military Academy.

through minute openings between the rotating band and the bore before and shortly after the projectile begins to move. *Second*, that erosion is accounted for by chemical and structural changes in the surface of the bore due to the contact of powder gases at high temperature. *Third*, that the bore is worn by the passage over the surface of highly heated gases at great velocity. *Fourth*, that the gases transmit enough of their heat to the bore to melt its surface. *Fifth*, that the moving projectile abrades the bore mechanically. *Sixth*, that the surface of the bore expands from the heat and is permanently deformed; when it cools, the metal fails to return to its previous position, and cracks by contraction.

As to the first theory, the escape of the powder gases past the rotating band, the highly erosive effect of hot gases escaping through small orifices is well known. As the projectile is seated initially, the rotating band fills the grooves of the rifling only slightly, undoubtedly permitting the escape of gases until the projectile begins to move. As soon as the band is forced fully into the rifling, the bore should be effectively sealed. But the movement of the projectile immediately produces abrasion of the band, and it is unreasonable to suppose that this abrasion is replaced since copper is characteristically inelastic. Thus the bore is sealed completely, if at all, only momentarily. The projectile acquires velocity relatively slowly, while the pressure and velocity of the escaping gases rise to a maximum with great rapidity, conditions which would explain the excessive erosion which takes place near the seat of the rifling. As the projectile moves down the bore, the openings about the band increase, but the projectile has acquired velocity and the gaseous pressure has fallen far below its maximum, which explains the observed absence of erosion during this portion of the travel. At the instant the projectile leaves the muzzle there is a momentary rush of gas past the rear edge of the band as it emerges, eroding the muzzle slightly. For each succeeding round, the escape of gas begins earlier, and the erosion proceeds backward along the bore, due to the inelasticity of the band. Thus the theory explains, at least in a general way, the observed results.

THE theory is opposed on several grounds. It fails to account for the observed fact that the lands are more eroded than the grooves, since the former should be more perfectly sealed than the latter. It fails also to explain the pronounced erosion of the driving edges of the lands. There is erosion also in rear of the rifling, which cannot be due to the escape of gases past the rotating band. It is contended that, if the bore is eroded by the escape of gases past the rotating band, the band itself should be even more eroded, since copper is much softer than steel; whereas, recovered projectiles fail to show evidences of erosion. This objection may be answered to the effect that the erosion due to a single round is very slight, the effect being distributed among many projectiles and accumulated in the bore. Moreover, the abrasive effect on the band undoubtedly would obliterate all evidences of gaseous erosion. In addition, there are many cases of small arms bullets, particularly those fired from badly eroded bores, which have shown deep scoring due to powder gases.

Perhaps the best support of the first theory as at least a contributory cause of erosion is the fact that experiments have shown that changes in the form and size of the rotating band have had a marked effect on the observed erosion.

The second theory of erosion relates, as has been stated, to the chemical and structural changes in the metal on the surface of the bore, due to contact with the powder gases. The reactions occurring on explosion are very complex, and vary with the composition of the powder. The principal products of combustion are carbon dioxide, carbon monoxide, water and nitrogen. It is conceivable that large amounts of carbon monoxide may be formed. This compound is a good carburizer, and it may well be possible that the carbon content of the surface metal is increased gradually by repeated firing, resulting in cementation under the conditions of high temperature and pressure. This action would produce a hard, brittle layer on the surface of the bore, so that the metal would flake and chip under the violent action of the powder gases and the projectile. Examination of guns which have burst has shown that, after repeated firing, the metal next to the bore is exceedingly hard and can scarcely be cut with a file, making clear that the composition and crystalline structure have been changed by the action of the powder gases. The surface metal presents a dark appearance in contrast to the silver gray of the original metal. While the theory offers a plausible explanation of the erosion near the seat of the rifling, it is difficult to understand its application to the observed increase of erosion near the muzzle.

The third theory is based, not on the escape of gas through small openings as in the first theory, but on the supposition that the heated metal of the surface of the bore is worn away by the velocity, pressure and temperature of the gases in rear of the projectile. The metal supposedly is softened and then ejected by the physical action of the moving gases. The metal removed by any one round, of course, would be very small, but the effect of a considerable number of rounds would be appreciable and would increase rapidly after the surface of the bore became roughened. The motion of the gases is an essential element of this theory, as is shown by the fact that the rear part of the powder chamber is not eroded even by prolonged firing, nor is the inner surface of a bomb in which charges are burned for experimental purposes. It is claimed that this theory is supported by the physical appearance of eroded test specimens. The theory accounts for the erosion near the muzzle, since the velocity of the gases is increased greatly as soon as the projectile leaves the bore. It explains the observed erosion in rear of the rifling, but not the fact that the lands are eroded more than the grooves nor the excessive erosion of the driving edges of the lands.

AS for the fourth theory, it is unnecessary to assume that the movement of the gases rubs off the softened metal; it may be that the motion of the gases over the surface of the bore acts merely to transmit heat to the metal and melt it away. It is well known that the transfer of heat from gas to a metallic surface is assisted greatly by movement of the gas. Although powder gases have a low specific heat, the quantity of the gases is great and their temperature is very high, making it quite possible that the quantity of heat transferred is sufficient to soften and even melt the metal. It can thus be explained why the remarkable physical properties of certain steel alloys, acquired by heat treatment, are of no avail in preventing erosion, since the crystalline structure is broken down in the preliminary stages of liquefaction. The theory accounts for the great

erosion near the origin of the rifling, since this portion of the bore is exposed to the action of the moving gases longer than the surface nearer the muzzle. The greater erosion of the lands also is to be expected, since they project into the hot gases and receive more heat, while the grooves radiate the heat more readily. The theory does not account for the excessive erosion of the driving edges of the lands, nor for the increased erosion at the muzzle.

The fifth theory, the abrasion of the bore by the projectile, is advanced as a contributory cause of erosion. The familiar and dismal parallel of the hot box is sufficient to make the situation clear. The bore is a bearing which is highly heated and unlubricated; the shaft, the projectile, is not only revolving at great speed, but is sliding along the bearing as well. That there is abrasive effect is apparent. Experiments in the Navy showed that erosion was reduced nearly one hundred per cent by coating the projectile with paraffin. Coating the projectile with vaseline reduced the erosion materially. Abrasion would account for the greater erosion of the lands, particularly the driving edges, but not for the erosion of the bore in rear of the rifling nor for the increased erosion near the muzzle. If erosion were due only to abrasive action, it would seem that the effect should be distributed more generally along the bore, and increase with the travel of the projectile, which is not the case.

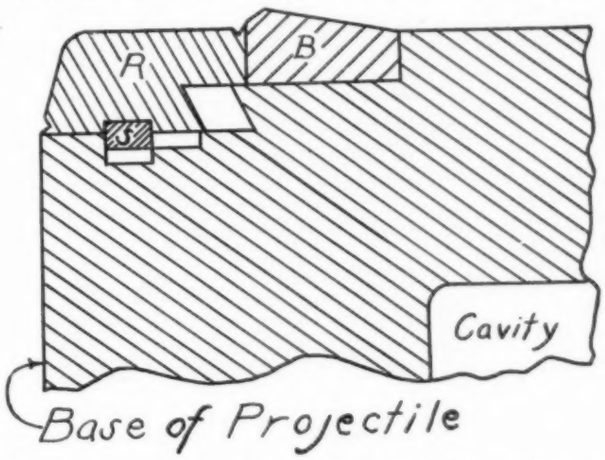
The sixth theory was advanced by the Russians prior to the World War. It supposes that, at the moment of firing, under the influence of the high pressure and the temporary high temperature, the outer surface of the metal, heating up, quickly expands, and being unable to transfer all of its heat to the shrunken inner layers, there is a radial expansion which causes the surface of the bore to thicken and wrinkle. At the next shot the compression of the surface of the bore by the neighboring layers of metal is diminished by the fact that they in their turn have become heated. The network of wrinkles should thus be obliterated. This becomes impossible, however, because the raised parts of the metal are unlikely to return to their exact original positions. With further firing the roughness increases, the formation of rents proceeds, and grooves ultimately develop through which the powder gases can pass. It is also conceivable that some of the roughened metal may actually be removed by the projectile and the gases, both moving at high velocities. It is to be noted that this theory does not account for the erosion at the muzzle.

FROM the foregoing discussion of the theories of erosion, it is clear that the causes may be placed in three categories: First, the powder gases in rear of the projectile; second, the abrasive action of the projectile itself; and third, the escape of gases past the projectile. Quite naturally efforts to reduce erosion have been, and must continue to be, directed toward lessening the adverse effects of these causes.

The field of experiment offered by the gases in rear of the projectile is extensive, but difficult and even discouraging. Metal inevitably is affected by heat; the temperatures, pressures and velocities unavoidably are high; all deleterious constituents of the powder gases cannot be eliminated. Nevertheless, progress has been made and more is to be expected. The powder has been improved with respect to its erosive properties; for example, the substitution of nitrocellulose for nitroglycerin and of low nitration for high nitration previously mentioned. Whether further progress in this direction is possible is problematical. Efforts to develop a gun steel which is more resistant to erosion have not been especially encouraging. Experiments were conducted recently at Springfield Armory with caliber .30 machine gun barrels of various special steels. Stainless steel, tungsten steel, and chromium plating of the bore were tried in comparison with the present fnild gun steel barrels. The results indicated little or no superiority in the matter of erosion and accuracy life.

As has been found actually, and as would be expected, the abrasive action of the projectile is substantially reduced by the introduction of a lubricant. It appears, however, that insufficient stress is placed on this feature in the instructions issued to the service, although the necessity of keeping the bore and projectiles clean is emphasized.

As to sealing the rotating band during the travel of the projectile, it appears that this potential cause of erosion has been quite neglected. It is true that there has been much experimentation in connection with the form and position of the rotating band, but these efforts have been primarily in connection with stability and accuracy of flight; the effect on erosion has been somewhat incidental. It is evident that the present fixed copper band is a positive seal only initially, if even then; it does not adapt itself effectively to enlargements and irregularities of the surface of the bore. Whatever may be the merits of this feature as a possible cause of erosion, it certainly seems to deserve more attention than has been given it thus far. The accompanying diagram shows a type of band which would appear



to offer a promising field for experiment. As can be seen, the band *B* is a copper ring as at present, except that it would be heavier and more substantial. Mounted against the rear face of the band is a sliding ring *R*, secured in place by a split ring *S*, which in turn bears against a shoulder in the base of the projectile. When the piece is fired, the pressure of the powder gases against the ring *R* upsets the rotating band and forces it firmly outward against the surface of the bore in spite of the irregularities therein. Moreover, this action is continued positively throughout the travel of the projectile. The upsetting pressure on the band *B* may be controlled by varying the area of the rear surface of the ring *R*. While the effectiveness of such a band in reducing erosion is, of course, a matter of conjecture, its investigation would serve at least to confirm or eliminate the first theory of erosion.

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Industrial Mobilization

THERE is presented in this issue of Army Ordnance a description of the detailed plan and machinery for the mobilization of American industry in time of war. Papers are presented by the Assistant Secretary of War who, under the National Defense Act, is directly charged with the fulfillment of this portion of our war plans, and by other executives connected with his organization. There is also a description of the newest service school for the education of Army officers in industrial and economic subjects necessary in this work presented by the Assistant Director of the Army Industrial College. These articles and that of General Maurice present a very comprehensive picture of industrial preparedness.

It will be apparent to the reader, it is believed, that the work which has been and is being accomplished by the Assistant Secretary of War in this respect is the solution of the outstanding problem of the World War. Those charged with the responsibility for munitions supply ten years ago and even the casual looker-on of those days realized the serious lack of industrial planning for war. It was a wasteful and costly affair which would certainly have been overcome to some extent had time been taken by the forelock.

That the lesson has been learned is fully testified by the performance of the organization of the Assistant Secretary of War. Industrial planning today holds, as it should, a place coequal with tactical and strategic war plans. With these two principal factors of national defense on an even footing and with constant application of our best minds to the problems of both, there is every reason to feel that the national defense today is better planned and better understood than ever before. There are many necessary things to be done in the way of putting some of those plans into actual test operation, but at least the problem is known, a solution is at hand, and it cannot again be said that industrial planning has either been minimized or left out of the picture.

The Tenth Annual Meeting

THERE are several considerations in connection with the Tenth Annual Meeting of the Army Ordnance Association at Aberdeen Proving Ground on October 4th which deserve particular mention. The program of demonstrations has been acclaimed by many the most comprehensive exhibit of munitions of war during the past decade. Not only was ordnance in all its classifications shown and maneuvered but other classifications of munitions as well were included, notably a program by the Army Air Corps which attracted wide interest.

It is not an easy problem to handle and feed 10,000 people who assemble for one day for an occasion of this kind, and yet the arrangements at the Proving Ground in these respects were exellent. The traffic problem was well taken care of, and luncheon and supper served by the Quartermaster Corps was excellently done. The various organizations of the Army which particiipated in the program of events, and particularly the staff at the Proving Ground, all contributed in large measure to the success of the affair.

One of the most gratifying innovations, to our mind, was the program of the business meeting of the Association. The addresses given presented a well rounded picture of ordnance affairs to date. Mr. Crowell, the President of the Association, gave a succinct account of the affairs of the Association; General Williams, the Chief of Ordnance, presented a most enlightening paper on the present status of ordnance development; and James L. Walsh, Chairman of the National Defense Division, American Society of Mechanical Engineers, in a constructive discussion of practical preparedness, discussed phases of the defense problem which call for active and general action.

That the Association should bring together such large numbers of executives and engineers of American industry and assist in presenting to them concrete demonstrations of munitions developments and at the same time acquaint them with the facts as they are, is a real step in the direction of fulfilling the functions of the organization which, in their last analysis, consist in enlightening our people on the developments and needs of the national defense.

The Tenth Annual Meeting seems to testify that a knowledge of the design and development of munitions is being kept alive in the minds of the people which, after all, is one of the specific functions of the organization. So long as this interest is manifest the making of ordnance is not a lost art.

Election of Officers

AS announced in the proceedings of the tenth annual business meeting of the Association published elsewhere in this issue, the recent election of officers conducted by letter ballot, in accordance with the Constitution, resulted in the almost unanimous reëlection of Benedict Crowell of Cleveland, Ohio, as president; William W. Coleman of Milwaukee, Wis., and William C. Sprnance of Wilmington, Del., as vice-presidents; and R. P. Lamont, Chicago, Ill.; C. L. Harrison, Cincinnati, Ohio, and Frank A. Scott, Cleveland, Ohio, as directors. All these gentlemen, who hold high rank among the industrialists and financiers of the country, have been identified with the Association since its organization ten years ago. They continue to give unsparingly of their time and interest to what they and thousands of others feel is a very important movement.

Certainly the Association is to be congratulated on the assurance thus given that these gentlemen who have con-

ducted the organization so successfully in the past will continue to guide it in the future. By their presence in the affairs of the organization they symbolize the active interest of many others in civilian life who, having no official status in the affairs of the Government, can accomplish much for the national defense. They and others like them give to the Association that particular make-up which removes it from a service organization and emphasize its civilian industrial status.

Under their guidance the Association has become an established organization and has made tremendous strides. Its membership has grown steadily, its activities have progressed proportionately, and the soundness of its financial condition is most assuring.

Not only is the Association to be complimented on the character of coöperation received from these gentlemen, but in our opinion the country generally is most fortunate in having citizens of this type who assist so materially in making sure its adequate defense.

General Maurice on Industrial Preparedness

OF all the military leaders who played preëminent roles in the World War possibly none has a greater understanding of preparedness than Maj. Gen. Sir Frederick Maurice who served as Director of Military Operations of the British General Staff 1915-1918. An author whose writings have aroused world-wide interest, General Maurice is well equipped to state the fundamental military lessons of the great conflict. Because of his clear-cut analysis of the entire situation, and primarily because of his insistence upon the vital role of industry in war, his paper, "Military Lessons of the Great War," which was published in the October issue of *Foreign Affairs*, New York, is republished in this issue of ARMY ORDNANCE as a matter of general interest to our readers.

General Maurice quite logically visualizes future wars as conflicts of machines and accordingly stresses the industrial capacity of a nation in its relation to ultimate victory.

That the soldier should thus acknowledge the place of industry in war is comparatively new in the annals of defense. Not much more than a quarter of a century ago such an idea might have been considered quite revolutionary. In another sense, however, the idea is not so new since it has behind it ten years of actual trial in America and in other nations as well.

It is distinctly assuring to know that the system adopted by the American Government for a perfectly rounded defense meets in principle the ideas of so eminent a soldier as General Maurice.

Milwaukee Post, A. O. A.

THE number of local posts of the Army Ordnance Association was increased to ten during September, 1928, when the recently organized Milwaukee Post came into existence. Recognizing the industrial importance of Milwaukee and adjacent territory in Wisconsin, members of the Army Ordnance Association resident in that section decided that the time was opportune for the formation of such a local organization there. Under the guidance of William W. Coleman, who has served as a Vice-President of the Army Ordnance Association since its organization in 1919, plans were made for the formation of the new post, and these materialized at the first meeting of the organization on September 26, 1928. The inaugural meeting at which the formal presentation of the charter by the President of the Association will take place, will be held in Milwaukee on November 23rd.

Thus in the tenth year of the existence of the Army Ordnance Association the tenth local post is formed. To some this rate of growth may seem extremely slow. On the contrary, it can be taken as an indication of steady, natural development. Organizations and institutions which display a mushroom tendency very often exhibit the same degree of obsolescence. The healthier indication, we take it, is a gradual and effective growth without undue stimulation.

Industry in and around Milwaukee established remarkable records in this field during the World War. Its performance in the production of grenades alone gave it the *nom de guerre* "the grenade city." Its record in other fields of munitions production was equally impressive. It is eminently fitting that the lessons then learned should be perpetuated and enhanced by these same individuals and organizations through the medium of a local post of the Association.

Casper H. Rowe

THE directorate of the Army Ordnance Association suffered a distinct loss in the death of Mr. Casper H. Rowe, director representing the Cincinnati Post, who died at his home in Cincinnati October 21st.

Equipped with many years of business and financial experience which placed him in the front rank of financiers of his native city, Mr. Rowe brought to the Army Ordnance Association keen executive ability and an untiring interest in all Association affairs. He was instrumental in organizing the Cincinnati Post, and at the time of his death was its President. He served for various periods as Director, Vice-President and President of the Market National Bank of Cincinnati, and upon the consolidation of that institution with the Fifth Third National Bank in 1919 Mr. Rowe became First Vice-President of the new institution and also served as a Director until his death. He was likewise a director of the Cincinnati Car Company, Dalton Adding Machine Company, Shepard Elevator Company, and was a member of the Endowment Fund Committee of the University of Cincinnati.

Immediately following his death, the following resolution was adopted by the Executive Committee of the Cincinnati Post:

"A great loss, through the death of our friend and President, Casper H. Rowe, has been sustained by those nearest to him and by all those associated with him in the many enterprises with which he was connected and to which he had rendered such valuable service.

At a meeting of the Executive Committee of the Cincinnati Post, Army Ordnance Association, this day, it was Resolved, that we sincerely condole with his family on the dispensation with which it has pleased Divine Providence to afflict them, and that this heartfelt testimonial of our sympathy and sorrow be forwarded to his widow, and to the Army Ordnance Association of which he was a Director."

In his passing the Army Ordnance Association loses the active counsel and advice of one of its Board of Directors who gave unsparingly of his time to the national defense.

Professional

Edward C. Delafield Appointed to War Department Business Council

LIEUT. COL. EDWARD C. DELAFIELD, Fin. Res., New York, N. Y., has, upon the invitation of Col. C. B. Robbins, the Assistant Secretary of War, consented to fill the vacancy on the War Department Business Council caused by the death of Brig. Gen. Samuel H. Wolfe, Fin. Res.

Colonel Delafield is a prominent banker of New York City, being President of The Bank of America and identified as director in many other financial institutions. He served as major, then lieutenant colonel of the Xinth Coast Defense Command of the New York Guard, where his services were of a conspicuous character. He was chairman of the committee of the regiment that put over a very large amount of the Liberty and Victory Bonds, and having taken a course at Camp Perry, entered enthusiastically into the promotion of rifle practice among the members of the regiment. He has served in the Finance Reserve since July 16, 1924.

By amendment to the National Defense Act, approved June 4, 1920, the Assistant Secretary of War is charged under the Secretary of War with the "supervision of the procurement of all military supplies and other business of the War Department pertaining thereto." To assist the Assistant Secretary in carrying out this provision of the National Defense Act he has organized the War Department Business Council for the purpose of advising him as to:

Whether he has an organization, procedure and control which will insure efficient supervision of procurement and proper utilization of the consolidated buying power of the Army:

Whether the supply branches of the Army have an organization, procedure and control which will insure efficient procurement by their purchasing agents; efficient supervision of procurement by their chiefs as well as proper utilization of the consolidated buying power of their branch.

The present membership of this council is: Leonard P. Ayres, Vice-President, Cleveland Trust Company, Cleveland, Ohio; James B. Bonner, United States Steel Corporation, Washington, D. C.; John J. Carty, Vice-President, American Telephone and Telegraph Company, New York City; Howard Coonley, President, Walworth Company, Boston, Mass.; F. S. Dickinson, President, Becton, Dickinson and Company, Surgical Instrument Manufacturers, Rutherford, N. J.; Edward C. Delafield, President, The Bank of America; George F. Dryden, President, Dryden Rubber Company, Chicago, Ill.; Clinton G. Edgar, President, Continental Sugar Company, Director Wabash Railroad Company, Detroit, Mich.; S. M. Felton, Chairman, Board of Directors, Great Western Railway, Chicago, Ill.; C. W. Nash, President, Nash Motors Company, Kenosha, Wis.; Oscar W. Smith, President, Park, Davis & Company, Detroit, Mich.; William C. Spruance, Vice-President, E. I. dePont de Nemours Company, Wilmington, Del.; William A. Starrett, Vice-President, Starrett Brothers, Contractors, New York City; Gerard Swope, President, General Electric Company, New York City.

Small Arms Competitions

THE Ordnance Reserve Officers of the Second Corps Area know how to keep the pistol in proper working order—and they also know how to use it. The fact that they know both ends of the weapon was demonstrated when the pistol team gathered in all of the trophies put up for competition in the Second Corps Area during the past season. These included the "Bell Trophy," Army Ordnance Association Trophy, and the Leonard Wood Cup.

And furthermore, just to show that they also know something of the use of the rifle, the same team took the small bore match for the McNary Branch Team Rifle Trophy.

The Bell Trophy, a silver cup presented by Col. Julius O. Adler, Inf. Res., open to organization teams from all branches in the Second Corps Area, started with 16 teams entered. Elimination trials resulted in the final match being shot by the 303rd Cavalry and the Ordnance team, which the latter took with the general average for the contests of 91.53 per cent.

The conditions of the Bell Trophy contest were 30 shots at 15 yards on a reduced "L" target, 10 shots in 30 seconds, 10 in 15 seconds and 10 in 11 seconds, and 10 shots at 25 yards, bobber target, 3 seconds per shot.

The Army Ordnance Trophy Match was open to Ordnance teams from all the Corps Areas. The conditions were 20 shots, time fire, at 25 yards; 10 shots at 25 yards in 15 seconds, and 10 shots at 15 yards in 11 seconds. The First Corps Area team finished second. The Second Corps Area team average for this match was 88.75 per cent.

The Leonard Wood Trophy, offered by Col. Cyrus Field Judson, Ord. Res., for any branch team in the Second Corps Area, had 11 entries, elimination resulting in the final match between the Signal Corps and the Ordnance Department. The latter took the event with a general average of 86.20 per cent. The conditions were the same as for the Army Ordnance Association Trophy competition, except the 11 seconds stage being shot at 25 yards instead of 15 yards.

The small bore Rifle Match for the trophy and medals presented by Col. James E. McNary, Ord. Res., was contested for by the Coast Artillery and Ordnance teams, the latter taking the match with an average of 92.8 per cent. The conditions for this match required two scores of 10 shots each at 100 yards on a reduced standard target.

The members of the Ordnance Team ascribe their success to the weekly practice arranged and supervised by Capt. Charles H. Keck, Ord. Dept., U. S. A., Executive Officer of the Nondivisional Ordnance Units. In some manner, known only to himself, he managed to provide ammunition and to secure the range of the 102nd Engineers, New York National Guard, for both pistol and rifle practice.

The team also had opportunity for outdoor practice at the range of the Camp Fire Club of America at Briarcliff, New York, through the invitation of Maj. John W. Hession, Ord. Res., one of the best known shots in the country and also a member of the Ordnance team.

The trophies and medals were presented to the team by Maj. Gen. Hanson E. Ely, Commander of the Second Corps Area.

The summary follows:

Bell Trophy

Ordnance Team	General Average
Capt. Christopher L. LeVien (Team Captain)	94.41
2nd Lieut. Walter A. Menger	93.66
Lieut. Col. Calvin H. Goddard	93.16
Capt. Clarence H. Bobb	90.33
1st Lieut. Lawrence J. Corsa	86.08
Team average	91.53

Leonard Wood Cup

Capt. Christopher L. Le Vien	89.42
2nd Lieut. Walter A. Menger	88.42
Lieut. Col. Calvin H. Goddard	86.75
Capt. Clarence H. Bobb	84.91
1st Lieut. Lawrence J. Corsa	82.17
Team average	86.20

New York Post Army Ordnance Trophy

Capt. Christopher L. Le Vien	91.75
Capt. Clarence H. Bobb	89.25
Lieut. Col. Calvin H. Goddard	89.23
2nd Lieut. Walter A. Menger	87.50
Maj. John W. Hession	86.00
Team average	88.75

McNary Small Bore Trophy

1st Lieut. Lawrence J. Corsa (team captain)	97.5
Capt. Clarence H. Bobb	96.00
Capt. Christopher L. Le Vien	95.00
2nd Lieut. Francis P. Webster	89.00
1st Lieut. Daniel H. Reed	86.5
Team average	92.8

Commercial Value of Hopcalite

AFTER a recent explosion in an Alabama coal mine, as reported in Circular No. 30 of the Bureau of Mines, eight men were trapped in the fifth right heading, with their only means of escape blocked by after-damp, the gaseous products of the explosion containing the deadly carbon monoxide. Two of the men who tried to make their way through were overcome by the gas and died. The others waited for help and, when equipped with self-rescuers, the chemical filling of which is a product of chemical warfare research, made their way through the fire damp unharmed.

The self-rescuer is a commercial pocket-size respirator consisting of a canister which is fitted with a mouthpiece, nose clip and exhalation valve. The chemical filling of the canister which eliminates carbon monoxide from the air breathed is a mixture of metallic oxides, known as Hopcalite. Hopcalite is a development of the Chemical Warfare Service which is employed not only in the miners' self-rescuer, but also in gas masks for firemen and other workmen who may encounter dangerous concentrations of carbon monoxide. It is also used in carbon monoxide recorders and alarm devices.

Prior to the discovery of Hopcalite, there was no type of gas mask which would provide protection against carbon monoxide, other than the oxygen inhalator, a cumbersome type of equipment which is a self-contained mask with its own supply of oxygen.

The chemical warfare researches which resulted in the discovery of Hopcalite, were carried out during the World War primarily to provide protection against carbon monoxide which might accumulate in dugouts and battleships as the result of explosions.

Carbon monoxide was not one of the so-called war gases, however, it is a very toxic gas and is one of the products resulting from the burning or detonation of military explosives. Many deaths resulted from carbon monoxide produced in this way. It was reported that in the battle of Jutland, there were many casualties from carbon monoxide poisoning on both sides. On one vessel alone several hundred men were fatally affected by carbon monoxide produced from burning cordite, a propellant explosive.

To provide protection against carbon monoxide was not an easy matter, since it is not absorbed or neutralized by the gas mask canister absorbents, charcoal and soda lime.

It was ultimately discovered, however, that a specially prepared granular mixture of the oxides of copper and manganese to which the oxides of silver and cobalt are sometimes added, would oxidize carbon monoxide when mixed with the oxygen of the air, to carbon dioxide, a relatively harmless gas. This mixture of metallic oxides is called "Hopcalite" in honor of the two universities, Johns Hopkins and California, at which the basic principles underlying such oxidation catalysts were evolved.

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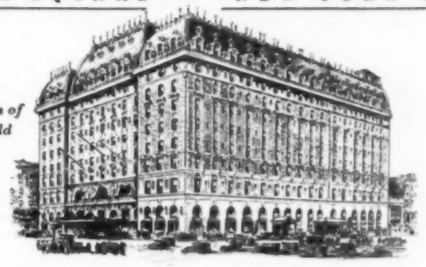
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Books

Fixation of Atmospheric Nitrogen. By Frank A. Ernst. New York: D. Van Nostrand Company, Inc. 1928. $2.50.

THE author's statement gives a correct idea as to the scope of usefulness of this book: "This book is not, therefore, intended for the scientist or technician familiar with the subject of the fixation of atmospheric nitrogen, but is intended for the technical man of other walks of life, for the teacher and student, for the business man and the banker."

Chapter I introduces the reader to the situation which brought into being the new fixation industry and Chapter II reviews briefly the development of the industry and the part which the various processes have played. Chapters III, IV and V are devoted to the three leading processes, the arc process, the cyanamide process, and the direct synthetic ammonia process. Chapter VI covers the economic conditions which govern the nitrogen industry. Items of cost and adaptability which determine the competitive strength of the various sources of nitrogen are discussed. In Chapter VII ammonia conversion products are taken up and the processes for converting ammonia into nitric acid, ammonium sulphate, ammonium phosphate, urea, ammonium sulphate-nitrate, and other new fertilizer materials are described. Chapter VIII is devoted to statistics. Appendices contain additional detailed data and bibliography.

This book is well proportioned in its subject matter and answers many of the questions most commonly asked in regard to the industry.

The A. E. F. in Battle. By Dale Van Every. New York: D. Appleton and Company. 1928. $3.00.

THIS is one of the best books concerning the World War which has been published. The author has been especially fortunate in including all of the essentials and just enough of the attending circumstances and local aspects to make it of interest to all and also a complete brief history of the actual fighting of the American Expeditionary Forces in Europe. This history, which is highly endorsed by Maj. Gen. H. E. Ely in an introduction, is written in an interesting and entertaining manner and should be of equal value to historians and others.

It includes descriptions of all of the battles in which our forces participated, including those vital factors of weather, terrain, and mental and physical condition of the enemy and friendly troops. It seems an easy matter when reading this book to place one's self in the place of the various combatants and to follow their struggle for the strategic control points. While success and defeat are dealt with impartially the reader is able clearly to differentiate between the impossible task unaccomplished, the repulse due to half hearted attack, the victory over seemingly insurmountable obstacles, and other debatable aspects of the engagements of our troops.

The reader will find the individual and his deeds not recorded except in very exceptional cases where their cor-

rect presentment seems pertinent. He will, however, find the deeds of the organizations most fully set forth and be able to place the credit for success or failure where due and feel that inner pride for his fellow-man in the strife of war wherein he distinguished himself most admirably.

Rhodes—A Life. By J. G. McDonald. New York: Robert M. McBride & Co. 1928. $5.00.

CECIL JOHN RHODES lived a short life of only 49 years but he accomplished in that time more than most men could ever accomplish. In all his endeavors he looked far into the future and acted accordingly, it is therefore perhaps in the future that his biography can be best written. His future biographer must have the personal views of those who were so fortunate as to have known him intimately as did this author, who herein presents a very clear and interesting analysis of his character through his words and actions and thus preserves priceless memories of this sterling character for posterity.

The life of Rhodes is of necessity a story of the development of South Africa, the country which gave back to him good health and in the advancement of which his life was wholly absorbed. Possessed as he was of such a dominating character he had staunch friends and bitter enemies and more often than not was opposed by almost unsurmountable obstacles, notwithstanding which he accomplished almost superhuman results, keeping foremost in his thoughts the idea of building up the British Empire for the future.

This book will help to straighten out those transactions wherein Rhodes was misunderstood and assist in bringing to light his true character. It is a well written, delightful biography, and an interesting drama of the struggles in the development of British South Africa covering 30 vital years.

Reputations! Ten Years After. By Capt. B. H. Liddell Hart. Boston: Little, Brown and Co. $3.00.

CAPT. B. H. LIDDELL HART, a keen observer and military critic, has undertaken a review of the lives and deeds of the following leaders of the armies engaged in the World War: Joffre, Gallieni, Petain, Foch, Haig, Allenby, Falkenhayn, Ludendorff, Liggett and Pershing. It may be a little disturbing to some to have their heroes' places shaken and to have events which have hitherto had little publicity brought to light and successes popularly attributed to one commander shown to have been due to the foresight and acumen of another.

However, it is most refreshing to read this book which deals so interestingly with the earliest beginnings and background and the subsequent events in the careers of each leader which finally led to the important and vital part each played in the great war. While new facts will be constantly brought forth, tending to glorify the fame of many of these men, Captain Hart has spared no pains to examine carefully all available material and to set forth in detail the reasons, as he sees them, why some of these officers have little claim to be idolized and others are entitled to far more recognition than they have yet received. This is an unusually clear and concisely written record and one which will be enjoyed equally by soldier and layman.

W. E. Gladstone. By Osbert Burdett. New York: Houghton Mifflin Co. 1928. $4.00.

MR. BURDETT gives a detailed and painstakingly careful study of Gladstone's life and career. He is almost too verbose and obscure, but one feels the underlying sin-

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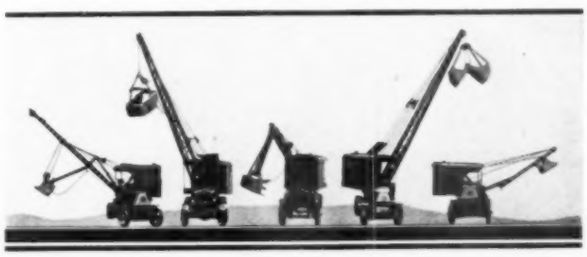

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cerity of the author in drawing this portrait. Perhaps he seems too harsh and unsympathetic at times in his conception of Gladstone, the "Grand Old Man" whom many of us from youth have been taught to revere and admire, possibly with more enthusiasm than wisdom.

It is most interesting to read this book directly after Maurois' "Disraeli," which is so full of charm and so delightful to read. Mr. Burdett's book in contrast needs must be sober and serious, reflecting accurately the more serious and religious nature of Gladstone's character. Gladstone's tremendous vitality and energy, his magnetism of voice and manner in his countless impassioned speeches pervades the entire book. Even when he was made Prime Minister for the fourth time at the advanced age of eighty-two, his extraordinary zeal and vigor still persisted.

One is made to feel how able and strong a statesman England had in Mr. Gladstone. He sought always to be the mouthpiece of the people—ever waiting to learn their thoughts and feelings before expressing himself on any subject.

Sam Houston: Colossus in Buckskin. By George Creel. New York: Cosmopolitan Book Corporation. 1928. $3.00.

SAM HOUSTON, ever a romantic figure in history, has been made to live again in the pages of this book. His tremendous vitality and bodily vigor typify well the extraordinary physique of our early forefathers, reared and schooled in the rigors and hardships of frontier life. Mr. Creel draws a very appealing and likable picture of Houston—his strong sense of honor, his great courage, both physical and mental, and his exceptionally keen understanding of men and events.

Mr. Creel, also, revivifies Andrew Jackson, Bowie, Austin and others of equal fame who lived and died in those stirring days before and after Texas won her independence from Mexico. The bloody fight at the Alamo, the treacherous slaughter at Goliad and the dramatic capture of Santa Anna at San Jacinto are graphically related.

Like John Paul Jones, Sam Houston died in poverty and was long discredited and unhonored by an ungrateful and unthinking country. All who read this book will realize fully what a great debt Texas and the United States owed and still owe to Sam Houston, uncouth and untutored though he was. He was always a man of fine instincts, of innate dignity, a saving sense of humor, and he acted the part of a true gentleman, according to his stern code.

Yarns of a Kentucky Admiral. By Hugh Rodman, Rear Admiral, U. S. N. Indianapolis: The Bobbs-Merrill Co. 1928. $5.00.

THIS delightful book by Admiral Rodman is full of amusing and interesting tales and descriptions dealing with his personal experiences during his fifty years in the Navy. As the admiral notes in the preface, the subject matter is not arranged in chronological or any other logical sequence but simply jotted down at odd times. This very informality and natural handling of his varied experiences makes for added charm and gives the reader exceptional pleasure.

Admiral Rodman has had particularly interesting details in his service and has made the most of his unusual opportunities. He was in the South Seas with Agassiz, with Dewey in Manila Bay, he represented the Navy in the

organization for operation of the Panama Canal, he did duty in Alaska and in China, he was in Oahu at the coronation of King Kalakaua, and last, but by no means least of his many important details, he commanded the American Battle Squadron with the Grand Fleet during the World War. He is a keen observer, a lover of nature in all her forms and has read to splendid advantage. Surely a fine type for the youth of our Navy to read about and emulate. His sincere loyalty and deep love for the Navy is most appealing. He says, "If I had to live it (my life) over, my first and only choice would be the Navy." A book well worth the reading!

The Remaking of Modern Armies. By Captain B. H. Liddell Hart. Boston: Little, Brown & Co. 1928.

The "Mechanization" of War. By Victor Wallace Germains. With a foreword by Major General Sir Frederick B. Maurice. London: Sifton Praed and Co. 1927.

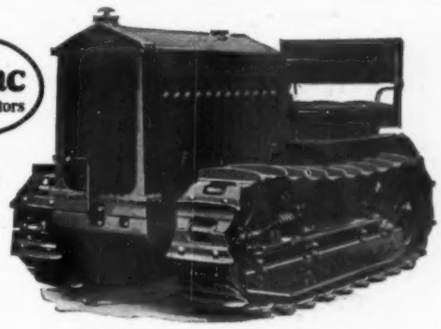
HERE are two excellent recent books by British authors on the "mechanization of war." They are particularly opportune because of the work on this subject now being carried on in the U. S. Army as exemplified by the Experimental Mechanized Force organized at Fort Leonard Wood, Maryland, last summer.

Captain Hart's book summarizes the "mechanization" movement as an effort to restore mobility to the offensive by the use of tanks and other new mechanical devices to overcome the stabilizing effect of the machine gun used in defense as in the World War. He refers to tanks as "heavy cavalry" and "mounted infantry" which will restore to the offensive the elements of victory: mobility, surprise, and shock. He shows historically that infantry fixes the enemy while cavalry is used to bring the decision. The author advocates the complete mechanization of the British Army, using as a strong argument the advantages accruing to a large industrial nation in thus changing the form of warfare. While presenting an excellent case for the much greater use of tanks and cross-country vehicles in warfare the author is a bit optimistic as to the rate of development of such vehicles in times of peace and their rapid procurement on a large scale on the outbreak of war.

Mr. Germains takes the conservative view of warfare. He makes much of the limited tactical successes and frequent mechanical failures of the small number of embryonic tanks used in the World War. Regarding the "mechanization" of armies of the size used in the late war, he shows well the excessive cost and bulk of such equipment. This book largely disputes Colonel Fuller's views and makes a good case against the *complete* mechanization of a national army.

As with most problems in life the correct answer lies, it is thought, between the views of the specialists and extremists. Reading these two books together one feels that the American Army has benefitted from the experiments in Europe by concentrating on developing a truly mechanized force to be used as a *special part* of the army and to act as a force of *heavy cavalry* and *mounted infantry* to clinch the decision in battle by its superiority in mobility, shock and surprise. No review can give a proper résumé of the great amount of excellent thought and information contained in these two books.

Both books are heartily recommended to every one interested in national defense.



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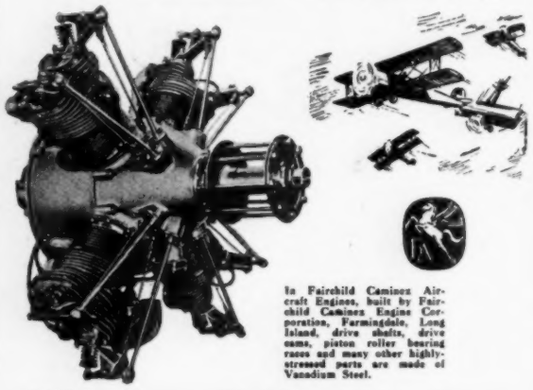

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Captain Hart's book contains also some interesting chapters on "the Napoleonic fallacy" (that the main objective in war is *always* the bulk of the enemy armed forces); on the training and selection of army leaders; on the post-war policies and equipment of the French and German armies; and on the use of gas.

National Policy and Naval Strength, and Other Essays. By Vice Admiral Sir H. W. Richmond, K. C. B., with a foreword by Lord Sydenham of Combe, G. C. S. I., F. R. S. New York: Longmans, Green & Co., Ltd. 1928. $6.00.

IN this collection of essays, Admiral Richmond never loses sight of Napoleon's maxim that "exclusivenesss of purpose is the secret of great successes and of great operations." The exclusive purpose of this book is that Great Britain shall ever keep in mind one supreme national object, i. e., the maintenance of maritime superiority. The author makes out a strong case for a continuation of this historic policy and supports his plea for recognition of this fact by the strongest historical evidence.

Written with commendable frankness and in an interesting style, the book will prove of the utmost value to the military and naval student. In addition to his main thesis, there are discussions of such topics as the use of history in the training of personnel for command; of coöperation between allies, between armies and navies, and between subordinate units of the same command; on the necessity of keeping subordinates informed. Admiral Richmond's chapter on "Thought and Discussion" is an especially valuable study, remarkable for its breadth of vision and liberal-mindedness, of the danger "of stifling initiative both of thought and action" inherent in armies and navies.

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